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A STITCH IN TIME

With its mask-fabrication capabilities and advanced textiles, Drexel's Center for Functional Fabrics became a lifeline to frontline workers in 2020.



CAST-NETTING
 Among the most difficult habitats to sample are large river rapids. One effective technique is cast-netting. Lead weights surround the perimeter of the circular cast net. They quickly sink to the bottom when thrown, trapping swift-water fishes like *Leporinus fasciatus* and *Leporellus vittatus*, two colorful members of the family Anostomidae.

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01

_HOW TO CATCH A FISH

The *study of unknown fish species and habitats* sometimes means you have to get your feet wet.

BEHIND EVERY DISCOVERY of a new plant or animal species are countless hours of careful work in the field, lab and library.

Some species are “discovered” when taxonomists pore over hundreds to thousands of specimen collections at the Academy of Natural Sciences of Drexel University and at other museums, comparing known species with creatures not yet added to Earth’s record. The more the taxonomist reads and compares museum specimens, the more he or she is able to distinguish new species from known ones.

Other times, scientists travel to places unexplored or poorly sampled, where they sometimes pour blood, sweat and tears into their work.

The pages that follow chronicle National Science Foundation-funded expeditions to Brazil’s Xingu River, an Amazonian tributary that hadn’t been extensively studied. In addition to yielding valuable new museum specimens to study, the fieldwork documented the natural aquatic diversity of the Xingu River.



Leporinus fasciatus



Leporellus vittatus



Banjo catfish (with eggs)
Aspredo aspredo



Knifefish
Orthosternarchus tamandua

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02

**TRAWLING TO
SAMPLE HABITATS**

Taxonomists employ a variety of gear and techniques to sample the different habitats where fish live. Here the team is using a submerged net that opens between two wooden doors when dragged along the river bottom. Trawling yields species exclusive to the depths of large river channels, like the nearly blind knifefish and the banjo catfish.



ICHTHYOLOGY



FLOODED FOREST REFUGES

Other habitats are only available in the high water season when the river floods its banks into the surrounding forest. Many fishes, including the arowana and tiger shovelnose catfishes, breed during this time, and the flooded habitats provide refuge for their young to mature.

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03



Arowana
Osteoglossum bicirrhosum

Sabertooth characin
Hydrolycus armatus



USING HAND LINES

Hand lines are another good way to sample large rapids, particularly deep swirling pools where large predatory fishes lurk during the day. Examples are peacock bass and sabertooth characin.



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04

ICHTHYOLOGY



Red-tail catfish
Phractocephalus hemiliopterus



Tiger shovelnose catfish
Pseudoplatystoma punctifer



Goliath catfish
Brachyplatystoma capapretum

METHOD
05 **USING BAITED LONG LINES**
Taxonomists also use baited long lines to sample large river channels. The line has many hooks and is set overnight in the channel. Long lines are effective for collecting large channel dwellers like the migratory catfishes pictured here.



2021



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A STITCH IN TIME
Drexel's Center for Functional Fabrics had just settled into its new state-of-the-art research facility on Drexel's campus when the pandemic arrived. In a rapid pivot, the center's 3D knitting machines and cutting-edge textiles became a lifeline to frontline workers in need of protective masks.
_by Britt Faulstick

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Ichthyologists get their feet wet in the search for new fish species.

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_ VISIT EXEL ONLINE



THE EVER-EXPANDING APPLICATIONS OF MXENES

A decade after Drexel researchers invented a tiny 2D material called MXene, its potential for engineering novel materials and applications has only increased - even in a pandemic.
_by Alissa Falcone

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SPECIAL REPORT: COVID-19 RESEARCH
PANDEMIC PROBLEM-SOLVING IN REAL TIME
The pandemic arrived in 2020 demanding our immediate attention; there was no immunity, no treatment, no time to lose. Drexel researchers acted fast, setting to work on new diagnostics, life-saving equipment and a vaccine - all funded by the University's "rapid-response" approach to research.
_by Alissa Falcone

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SPOTTING INVISIBLE INJURIES
A medical device startup housed within Drexel's School of Biomedical Engineering has spent years perfecting a brain injury scanner that is saving lives around the world as it travels a long but rewarding road toward U.S. commercial success.
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A PLAY ON THE BUSINESS OF RESEARCH
A neuroscience study on gaming with esports booster Comcast is the latest project orchestrated by the Drexel Solutions Institute as it remakes how higher education collaborates with external partners.
_by Lini S. Kadaba



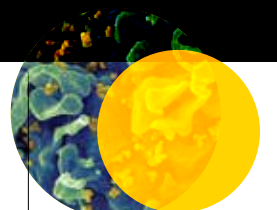
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Outrage over police killings in the summer of 2020 spurred researchers and the University to respond by creating a novel fund for "rapid response" scholarship.
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What's next for HIV research? While the dream of a cure remains, scientists are also studying ways to address the health impacts endured by those living longer lives with HIV.
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Virtual reality, creativity, refugee gaming, atomic bonds, city simulation, neural rewards, A.I. naps, liquid plasma.

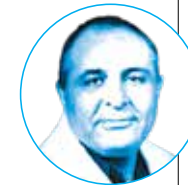


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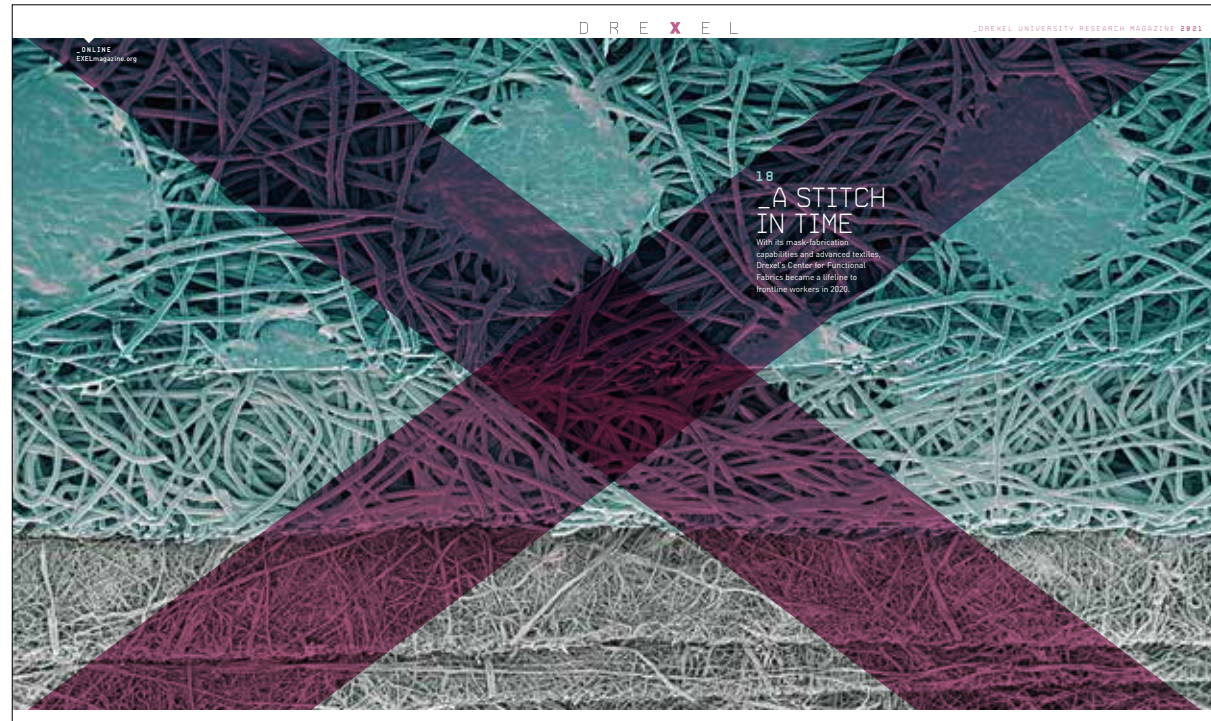
EXEL_MAGAZINE

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_URGENT INQUIRY

Research that responds to the moment



_ABOUT THE COVER
This magnified view of the layered fibers within a surgical mask was created by Oliver Meckes using SEM.

AS A RESEARCH UNIVERSITY with R1 status in the Carnegie Classification of Institutions of Higher Education Research, one of our greatest concerns when the coronavirus pandemic hit was how quickly Drexel faculty and graduate students could return to their labs. As it turns out, there was no need for concern. In a matter of weeks, Drexel's research enterprise was the first in the University to ramp up activity, with health and safety occupancy limits in place to safeguard our community. Research activity swung into high gear — including dozens of scientific inquiries into the causes, cures and possible solutions to this great challenge to the global community, as well as the need to bring about racial justice.

The Center for Functional Fabrics, featured in this issue of EXEL, played a major role by developing and producing new types of masks and respirators. The College of Medicine was a beehive of research activity, too. Meanwhile, Drexel's Office of Research & Innovation provided significant funding for faculty research projects focused on racial equity.

But our approach to research looks well beyond the current public health challenges. As you'll read in this issue's feature on the Drexel Solutions Institute, we are strengthening

our research capacity with a new, 10-year strategic plan that builds on the power of partnerships. This ranges from local solutions-based learning and civic engagement with communities and organizations in Philadelphia, to global research collaborations, to deep and productive relationships with a broad array of cross-sector employer-partners.

Finally, we're building out innovation districts on both ends of the Drexel campus: at Schuylkill Yards, where Spark Therapeutics is pioneering genetic breakthroughs in the transformed Bulletin Building, and at uCity Square, where a new academic tower will be home to Drexel's College of Nursing and Health Professions, and for the educational programs in the College of Medicine.

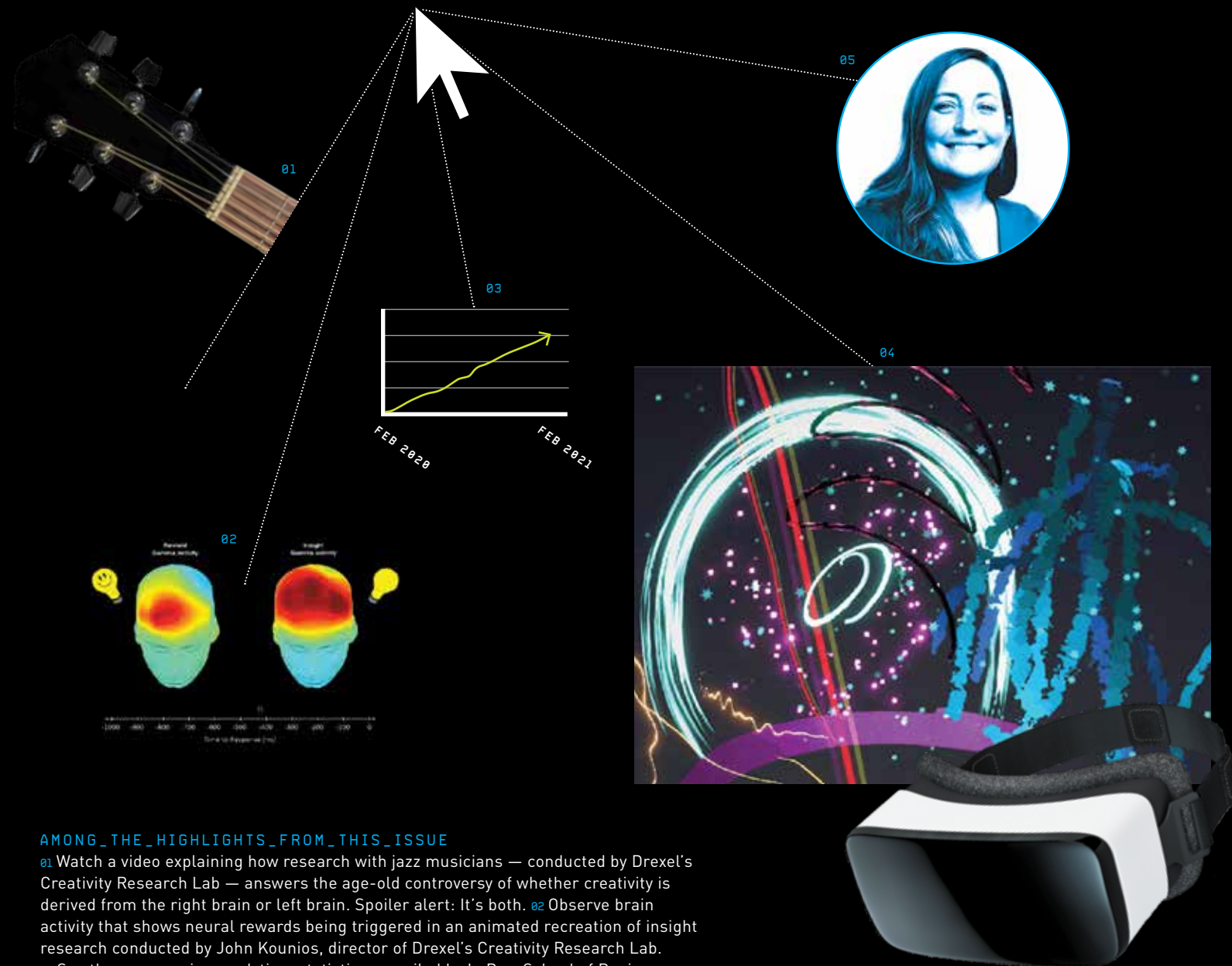
With new research awards up by nearly 30 percent over last year, the future of Drexel's research enterprise looks to remain strong and impactful, and ever focused on improving people's lives.

Sincerely,

John Fry / President

_EXPLORE EXEL ONLINE

Connect with EXEL Magazine at exelmagazine.org 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.



AMONG THE HIGHLIGHTS FROM THIS ISSUE

- 01 Watch a video explaining how research with jazz musicians — conducted by Drexel's Creativity Research Lab — answers the age-old controversy of whether creativity is derived from the right brain or left brain. Spoiler alert: It's both.
- 02 Observe brain activity that shows neural rewards being triggered in an animated recreation of insight research conducted by John Kounios, director of Drexel's Creativity Research Lab.
- 03 See the encouraging, real-time statistics compiled by LeBow School of Business researchers that show how four of the hardest-hit employment sectors rebounded from the pandemic downturn.
- 04 View intriguing 3D virtual reality artwork created during a free-form, immersive art-making session conducted as part of a College of Nursing and Health Professions study to evaluate virtual reality as a tool in art therapy.
- 05 Get the latest statistics on how families with children on the autism spectrum face higher levels of poverty, material hardship and medical expenses compared to households of children with other special health care needs, based on the National Autism Indicators Report from the A.J. Drexel Autism Institute.

AUGMENTED REALITY

_GETTING REAL VIRTUAL

The Immersive Research Lab opened in 2019 with an ensemble of virtual and augmented technology found at few universities. When the pandemic arrived, it became indispensable.

THE IMMERSIVE Research Lab opened in Drexel's Westphal College of Media Arts & Design in 2019 to train media arts students in the latest augmented and virtual reality technologies. Soon enough, though, the IRL lab was using those tools to help students and faculty across the University conduct basic coursework.

The unique, forward-looking workshop is equipped with specialized tools found at few universities. The equipment is used to create the realistic models and settings for movie visual effects, video games, computer visualization and now, virtual reality, augmented reality and other immersive media formats.

Some of the lab's technologies are the most current in the industry, like cutting-edge virtual and augmented reality devices from Oculus, Microsoft HoloLens and Faceware, as well as more than 100 individual software programs. To display student work, the lab includes three screening rooms, stereo and mono display screens, an Ambisonic sound system and a 16-foot diameter domed projection screen.

As the University rotated

to fully remote education in spring 2020, Program Director Nick Jushchyshyn showed everybody what the lab's top-notch alt-reality tools were capable of.

He built 3D virtual versions of lab bench equipment for College of Engineering faculty and helped a dance instructor create motion-capture demos of her dance choreography for her remote students. Using standard technology like photogrammetry and the free immersive-spaces software Unreal Engine, he built an award show stage for Westphal's annual Animation Festival. Drexel students were also able to participate virtually in the SIGGRAPH computer graphics conference using motion capture and virtual reality. IRL magic also brought together 20 members of Drexel's Music program and the Department of Performing Arts for an online winter jazz ensemble.

"While we are preparing students to make their mark in a field that is in a constant state of motion, one thing is for certain — this technology, which allows us to experience our world, and others, in new and exciting ways, is the new reality," says Jushchyshyn.

_INSIDE THE LAB

1 The 550-square-foot IRL lab is home to custom-built technologies developed for the lab by Assistant Professor and Program Director Nick Jushchyshyn (standing) and his collaborators.

2 Game design student Travis Hove '20 (pictured) worked within a multidisciplinary team of faculty and students to build a motorcycle-like platform with motion capture technology for immersive reality and gaming content.

3 The lab is home to a custom-built 360-degree virtual reality camera and a number of special headsets, such as the one Hove is wearing, that overlay three dimensional worlds into the visual field.

4 The OptiTrak virtual camera system in the hands of Jennifer Raimondi '20 (pictured) is used to pre-visualize in 3D how a computer-designed setting will look.



JEFF FUSCO

The IRL lab brought together 20 students in music and performing arts for a virtual winter jazz ensemble in November 2020, as COVID-19 cases were surging.



ONLINE
Download "Resilience" from Itch.io or visit SunGrazerStudio.com.

PSYCHOLOGY

DIGITAL MEDIA

MATERIALS SCIENCE

_RIGHT BRAIN V LEFT BRAIN

CREATIVITY IS OFTEN thought of as a product of the brain's right hemisphere — innovative people are labeled "right-brain thinkers" while "left-brain thinkers" are more analytical and logical. But some neuroscientists are skeptical of this idea, arguing that an ability as complex as human creativity must draw on vast swaths of both hemispheres.

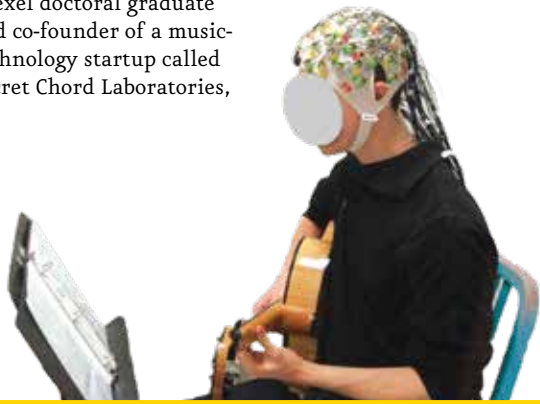


_JOHN KOUNIOS
Kounios is a professor of psychology in the College of Arts and Sciences and director of the PhD program in Applied Cognitive and Brain Sciences.

A brain-imaging study out of Drexel's Creativity Research Lab sheds light on this controversy by studying the brain activity of jazz guitarists during improvisation.

However, they also found that musicians who are highly experienced at improvisation rely primarily on their left hemisphere, suggesting that creativity is a "right-brain ability"

David Rosen, a recent Drexel doctoral graduate and co-founder of a music-technology startup called Secret Chord Laboratories,



THE_BRAIN_ON_JAZZ
The study was led by John Kounios with David Rosen, a doctoral graduate and co-founder of a music-tech startup. In this image, Rosen is improvising jazz while his brain activity is recorded.

when a person deals with an unfamiliar situation but draws on well-learned, left-hemisphere routines when a person is experienced at the task.

"If creativity is defined in terms of the quality of a product, such as a song, invention, poem or painting, then the left hemisphere plays a key role," says Kounios. "However, if creativity is understood as a person's ability to deal with novel, unfamiliar situations, as is the case for novice improvisers, then the right hemisphere plays the leading role."

led the study along with Professor John Kounios, who directs the Creativity Research Lab.

They found that creativity is, in fact, driven primarily by the right hemisphere in musicians who are comparatively inexperienced at improvisation.

_A SERIOUS PLAY ON THE REFUGEE CRISIS

"Resilience," a socially conscious city-builder video game set on an alien moon, blends game play with research and realism to bring the global refugee crisis home.

AN ESTIMATED 26 million people were living as refugees worldwide in 2020, according to the UN High Commissioner for Refugees. Millions who are forced to flee their homes settle in temporary refugee camps, where survival depends on an army of humanitarian workers who must manage a changing landscape of international policies and foreign aid while securing refugees' basic needs: shelter, food and water, medical care.



Lily Lauben '20, conceived of the game concept for "Resilience," which was designed and produced by SunGrazer Studio, a team of 18 students and several faculty members.

But what about...phone charging stations? Are they a necessity, too?

These are the kinds of considerations about the day-to-day needs and struggles of those on the forefront of this global crisis that await players of "Resilience," a research-driven, socially conscious "city-builder-style" computer game created by a cross-curricular team of 18 students and faculty advisors from the Westphal College of Media Arts & Design, the College of Computing & Informatics and the College of Arts and Sciences.

"Resilience" aims to raise awareness about the real-world needs and struggles of displaced people, albeit through a sci-fi veneer. The game is set in a refugee camp on an alien moon orbiting a wealthy intergalactic empire, populated by a four-eyed, cat-like species called Murians.

The importance of details like phone chargers was brought home to the student game designers while they researched 21st-century refugee conditions in preparation for game development.

their memories," says Lily Lauben '20, a game designer. "That's how they keep in touch with one another in camps. And so, having a phone charger, having a place to charge phones, is so important to them. ... It just humanized them a lot and in a way that I had never personally thought about before."

Like real-life refugees, the Murian species deal with family separations, sickness, estrangement and displacement, and trauma or longing for lives they left behind.

The insight encapsulates a major point they hope their game teaches.

"You think of refugees as being so different from you and coming from such different circumstances, but they have phones, too, and their phones have all of their photos from home and

The first-person player is likewise a Murian, in the role of a humanitarian aid worker who must manage the camp's budget, build facilities and maintain residents' wellbeing. The game's challenges intensify over time as money runs

out, overcrowding accelerates, facilities wear down and resettlement opportunities become scarce.

Alex Gallegos, BS game design '20, who served as technical director for the project, says the alien species was designed to look friendly, but also unfamiliar, and to arouse empathy.

"We wanted to make them look appealing and personable — both visually, but also in terms of their experience," he says. "When you talk to them, they have a really broad range of lines that they'll say and a lot of the lines

are very relatable to the everyday person. A lot of [their dialogue is] inspired by refugee stories from various articles or other sources that we came across."

To portray the "maximum reality" of life in a refugee camp, the students pored over reference materials from faculty advisors. Amelia Hoover Green, associate professor of politics and associate dean for Diversity, Equity & Inclusion in the College of Arts and Sciences, was enlisted to be Lauben's thesis advisor on the project due to her background teaching the intersectionality of fiction and political science.

Hoover Green urged the student team to give the first-person player the role of a humanitarian aid worker "middleman" who neither makes nor directly experiences refugee policies.

She also prompted the team to think deeply about refugee issues and compiled an extensive reading list to reference in the early days of the project.

"[It] included some traditional political science on earmarking and the politics of international organizations like the United Nations, but also epidemiology research on the spread of disease in camps and conflict studies literature about how camps can sometimes turn into microcosms of war," she says. "There were dozens of articles and books on the list."

The students used the research to build realism into "Resilience" while also striving to keep it engaging and commercially appealing.

In 2020, "Resilience" won the "Best Student Game" from New York-based nonprofit Games for Change. The organization runs an annual festival to showcase games that are socially conscious, educational or cause-based. The "serious games" category is a small but fast-growing segment of the global video games market.



_X-RAYS OF ATOMIC BONDS

Researchers are taking a closer look at atomic bonds between materials to understand how electrons behave at interfaces, which is critical for the design of future electronic technologies.

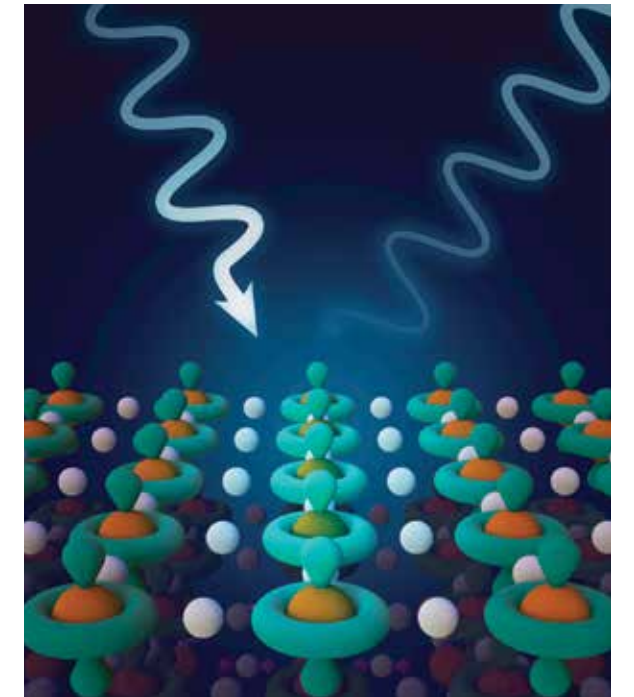


_STEVEN MAY
May is professor and department head of Materials Science and Engineering in the College of Engineering.

UNDERSTANDING electron behavior in an atomic bond is important to understanding or predicting the behavior of materials, and central to engineering a variety of devices used to process, store and transfer information.

Materials Science and Engineering Department Head and Professor Steven May and colleagues from Drexel's College of Engineering, along with researchers from the University of Saskatchewan and Lawrence Berkeley, Brookhaven and Argonne National Labs found a new approach for examining — with atomic-layer precision — changes in the behavior of electrons at the interfaces between two materials where they connect and interact.

Their work gives scientists a better way of unlocking the potential of engineering materials at the atomic level. The team's approach for making this experimental measurement involves a technique called resonant X-ray reflectivity. It can only be conducted in large synchrotron X-ray facilities, such as those operated by



CRYSTAL_CLEAR
To better understand the behavior of conductive and magnetic materials, researchers at Drexel are taking a closer look at their atomic bonds.

the U.S. Department of Energy, that generate X-ray radiation to probe the structure of materials. By tuning the wavelength of the X-rays to excite electronic transitions specific to individual elements within a material, the team was able to measure each element's electron contributions to their shared bond.

Understanding the function of unusual material interfaces, like those of quantum materials, could be the first step toward harnessing their properties to improve the processing power, storage and communications capabilities of electronic devices.

"Moving forward, we are excited about applying this technique to other classes of quantum materials, such as topological insulators and semimetals, to gain new insights into how interfaces alter magnetic and electronic character in those materials."

-Steven May

DIGITAL MEDIA

PSYCHOLOGY

COMPUTING

_IF YOU RAN THE CITY...

A new SimCity-style game uses public data to inform residents about the impact that real estate development can have on urban neighborhoods.

PRETEND YOU'RE the city manager, and a real estate developer wants to build a supermarket on a parcel in your neighborhood. It would improve food access and bring jobs into the community, but it would also mean razing affordable housing. What do you do?

This is one of the game scenarios players will face in Simulated Interactive Management of the City of Philadelphia (SIM-PHL), a new SimCity-style game created by designers from the Westphal College of Arts & Sciences with support from the John S. and James L. Knight Foundation's Open Data initiative. The game is set in the city's Mantua neighborhood, an area that is part of a national initiative to support and restore marginalized communities.

The city-simulator game uses public data from the city to inform residents about the impact that real estate development can have on rental rates, food distribution, crime, population flight, political struggle, gentrification and other forces that shape urban neighborhoods.

"Despite the significance of real estate data in the lives of the average Philadelphian, these data remain inaccessible, either by design, or because little effort has been made to present it in a format that engages the public," says project leader Frank Lee, who is director of Drexel's Entrepreneurial Game Studio.

In the game, players face complicated decisions about zoning, housing and the preservation of open spaces and historical sites. They must try to work for the good of the community while contending with challenges — all drawn from real-life incident reports in Philadelphia's database — such as contested zoning requests, damage from natural disasters and political pressure.

"These are all difficult decisions and they all have serious ramifications for citizens," Lee says. "If by playing this game people gain a better understanding of the real effect of policies, they can become even more effective advocates for their communities."



Project leader Frank Lee is working with Philadelphia-based Gosamer Games, a game design company run by alumni of Drexel's Entrepreneurial Game Studio, to release SIM-PHL for Android and iOS devices.

_AHA! & AHFFF

WHAT DROVE the evolutionary development of creativity? A new neuroimaging study from the College of Arts and Sciences points to an answer.



YONGTAEK OH Oh is a PhD doctoral candidate in the Department of Psychology in the College of Arts and Sciences.

Led by doctoral candidate Yongtaek Oh and Psychology Professor John Kounios, director of Drexel's Creativity Research Lab, the study (published in NeuroImage) revealed that creative insights can trigger a burst of activity in the brain's reward system, the same pathways that also respond to delicious foods, addictive substances, orgasms and other basic pleasures. Sudden experiences of non-obvious perspectives, ideas or solutions can lead to

ally rearranging letters.

The test subjects also filled out a questionnaire that measured their "reward sensitivity," a personality trait that reflects the degree to which an individual is motivated to gain rewards rather than



ZAP_CAP

Researchers prepare a test subject by dispensing conductive electrode gel into the electrodes in an electroencephalogram (EEG) cap.

inventions and other breakthroughs, with the added benefit of causing a rush of pleasure in some people.

The team recorded people's high-density electroencephalograms (EEGs) while they solved anagram puzzles. The activity required them to unscramble a set of letters to find a hidden word. Some solutions were achieved as insights that suddenly popped into awareness, while others were generated by methodic

avoiding losing them. Low-reward-sensitivity subjects experienced nearly as many insights as the high-reward-sensitivity ones, but their insights did not trigger a significant neural reward response.

So what can we conclude? Neural reward is not a necessary accompaniment to insight, though it occurs in many people and some people experience creative insights as intrinsically rewarding.

_A NAP FOR A. I.

IMAGINE STARING at a computer screen for days on end without even a millisecond of downtime. Given no other mechanism to modulate the input signal, the neurons in your brain would be continuously forced to fire, eventually spiraling out of control.

In the same way, a team made up of College of Computing & Informatics Associate Professor Edward Kim with researchers from the Los Alamos National Laboratory discovered that simulated neural networks become unstable after continuous periods of processing analogous to unsupervised learning (such as when a system is searching for patterns in a large collection of data).

The researchers found that the systems regained stability when exposed to states that are analogous to slow-wave patterns that human brains experience while sleeping. They created this state by injecting Gaussian noise waves, made of varying frequencies and amplitudes, into the neural network — like turning on AI's own little white-noise machine.

Their discovery was published in the Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, and was also featured in Popular Mechanics, Discover Magazine and Fortune.

What's next for the researchers? Implementing their algorithm on Intel's Loihi neuromorphic chip, which mimics the neural structure of the human brain. By letting the chip catch some metaphorical Zzz's, it might better process information from a silicon retina camera.

_LIQUID PLASMA FUELS A BREAKTHROUGH

Drexel's C&J Nyheim Plasma Institute is the first research center to use liquid plasma to synthesize a new clean fuel.

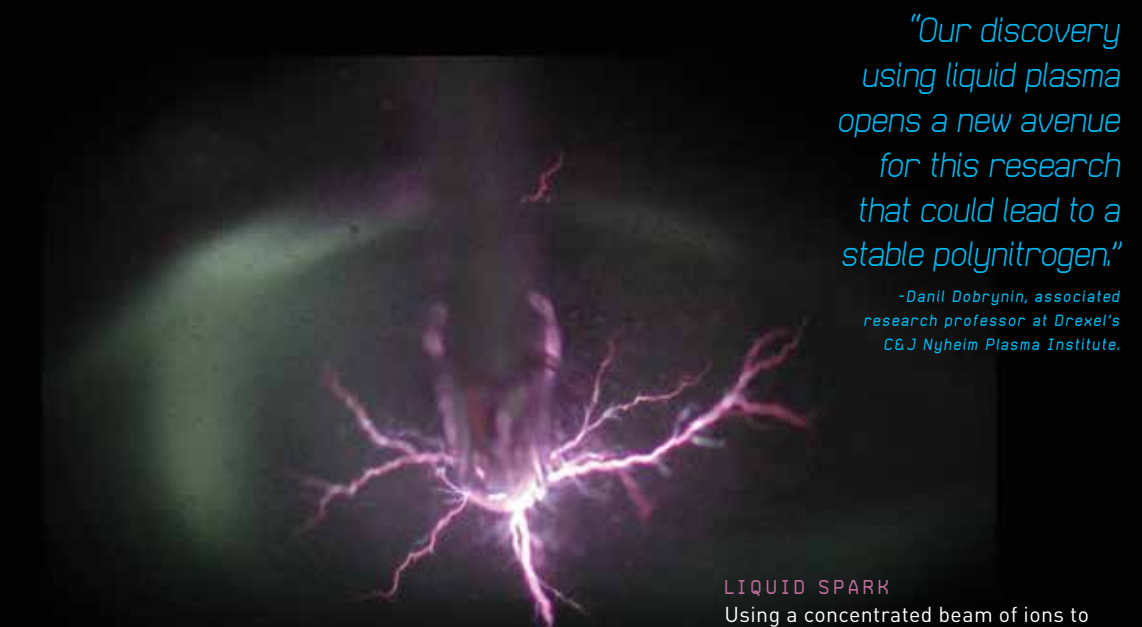
FOR DECADES, scientists theorized that energy stored in the atomic bonds of nitrogen could one day be a source of clean energy, but they struggled to coax nitrogen atoms into linking up.

Not anymore. Researchers at Drexel's C&J Nyheim Plasma Institute have proven that it's experimentally possible — with some encouragement from a liquid plasma spark.

The possibilities for using pure polymeric nitrogen — also known as polynitrogen — as a clean fuel source, for energy storage or as an explosive, are endless. It was purely theoretical, however, until Drexel researchers found that it could be produced by zapping a compound called sodium azide with a jet of plasma in the middle of a super-cooling cloud of liquid nitrogen.

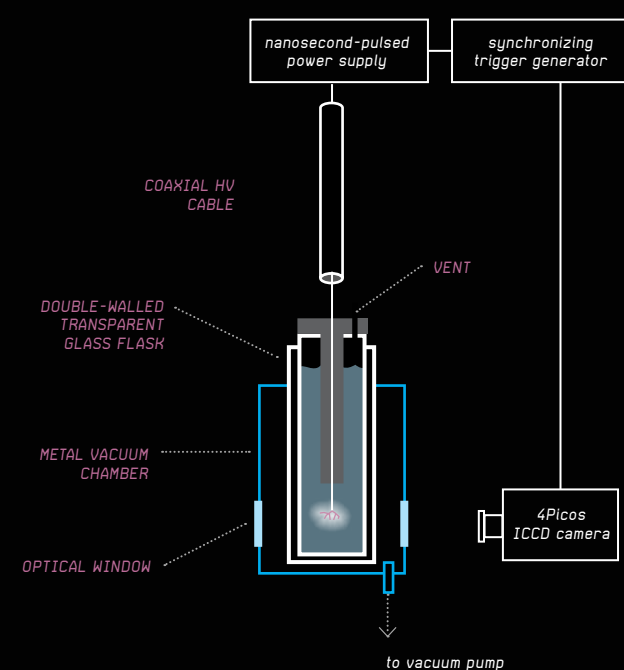
The result is six nitrogen atoms bonded together — a compound called ionic, or neutral, nitrogen-six — that is predicted to be an extremely energy-dense material. This research was the first instance of liquid plasma being used to synthesize a new material.

"Versions of polynitrogen have been experimentally synthesized — though never in a way that was stable enough to recover to ambient conditions or in pure nitrogen-six form," says Danil Dobrynin, an associated research professor at the Nyheim Institute and lead author of a paper detailing the discovery in the Journal of Physics D: Applied Physics.



"Our discovery using liquid plasma opens a new avenue for this research that could lead to a stable polynitrogen."

-Danil Dobrynin, associated research professor at Drexel's C&J Nyheim Plasma Institute.



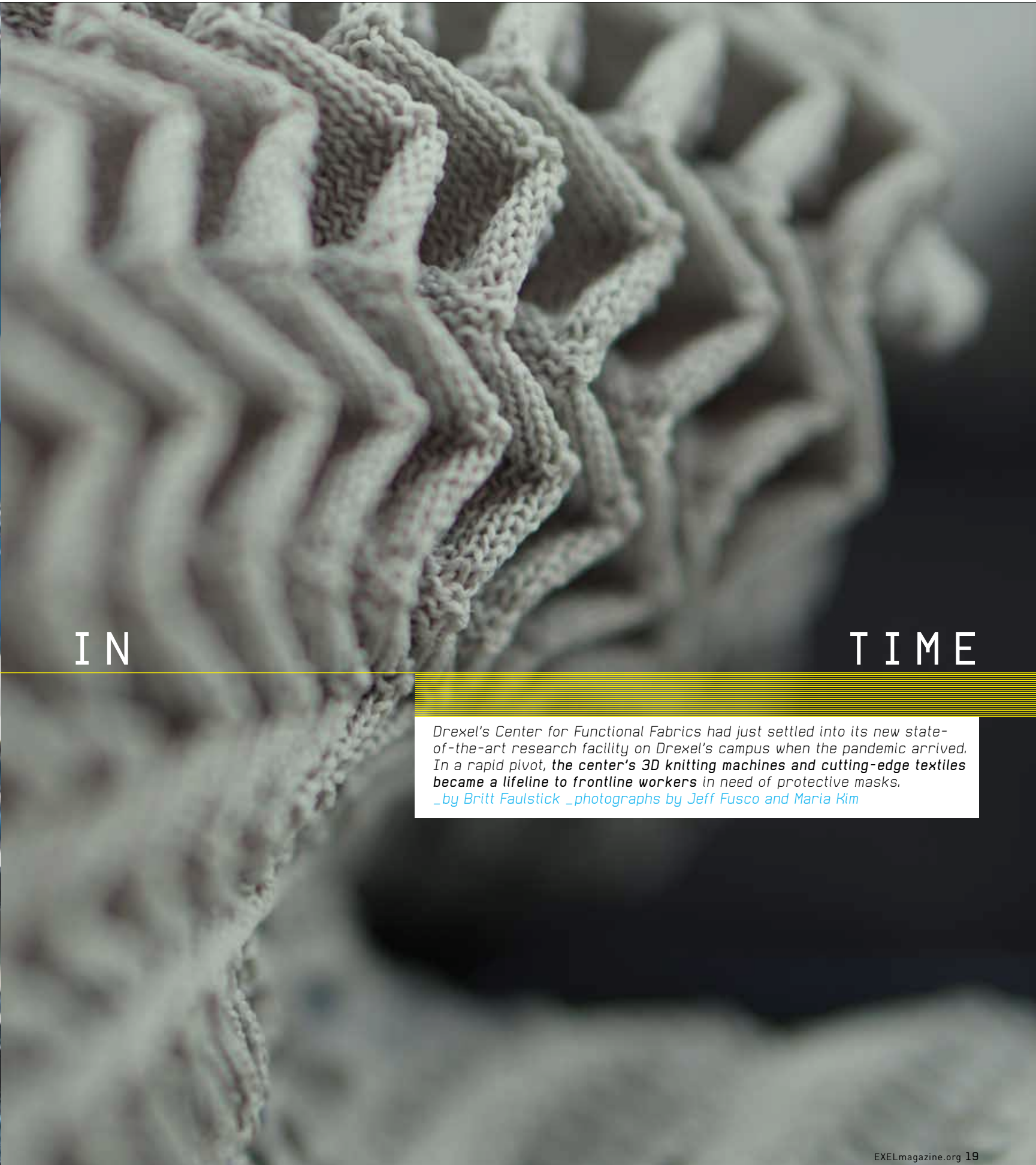
LIQUID SPARK Using a concentrated beam of ions to excite nitrogen compounds in liquid nitrogen, researchers at Drexel's C&J Nyheim Plasma Institute have produced an energy-dense material, called polymeric nitrogen, in pure form at near-ambient conditions for the first time.

WHAT IS LIQUID PLASMA?

Plasma, in its original gas-laden environment, has been under development for decades as a sterilization technology for water, food and medical equipment, as well as for coating materials. Liquid plasma, by comparison, has been around for barely a decade, though it already holds a great deal of promise. It is an emission of an ion-dense matter generated by a pulsed electrical spark discharged in a liquid environment. It was pioneered by researchers at the Nyheim Plasma Institute, who have explored its use in a variety of applications, from health care to food treatment.

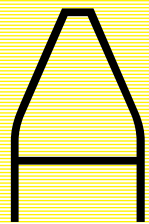


A STITCH



IN TIME

Drexel's Center for Functional Fabrics had just settled into its new state-of-the-art research facility on Drexel's campus when the pandemic arrived. In a rapid pivot, the center's 3D knitting machines and cutting-edge textiles became a lifeline to frontline workers in need of protective masks. [_by Britt Faulstick](#) [_photographs by Jeff Fusco and Maria Kim](#)



S THOUSANDS OF AMERICANS fired up their sewing machines to make masks last spring, Geneviève Dion, the director of Drexel's Center for Functional Fabrics, was thinking about how her team could contribute to the nationwide effort to protect people from COVID-19. The group had barely settled into their new home — a state-of-the-art facility for prototyping and studying next-generation textile technology — when the pandemic hit, halting research and silencing the center's array of digital knitting machines.

So, Dion did what she's come to be known for at Drexel; she figured out a way to move forward.

"We adapted to help meet an urgent need," she says. "We built the center to be able to go from prototyping to pilot production, and the pandemic made us prove we could do it."

Before her arrival at Drexel in 2007, Dion had already built a reputation for adapting the techniques and tools of fashion and industrial design to produce beautiful bespoke pieces.

In her work, Dion used the Shibori process, an ancient Japanese dyeing technique that involves binding and pleating fabric as it receives color, as a way to give planar materials unique three-dimensional patterns. To achieve her vision, she created her own tools to fold fabric and invented a process that permanently textures silk, earning her recognition as an innovator of the form. Her design work remains in the permanent collections of the de Young Museum in San Francisco and the Victoria and Albert Museum in London.

Creating new tools and processes sparked Dion's curiosity about the emerging field of smart textiles and how fibers and fabrics can be imbued with new capabilities to produce textile devices. Coming from a labor-intensive couture world, she quickly recognized that developing advanced manufacturing processes for these new products would be essential.

"I was drawn to knitting," Dion says, "because I recognized the need for automation and advanced manufacturing at the onset of the creation of smart textiles. Digital knitting can rapidly prototype a 3D form as a single piece and scale for manufacturing on the same equipment."

Dion's curiosity led her to an associate professor role in Drexel's Westphal College of Media Arts & Design, where she formed a partnership with Japan's digital knitting machine manufacturer Shima Seiki to open one of the country's first advanced textile research and innovation centers in 2012. With the University making strategic investments to expand its place in the city's innovation economy, Dion's center presented a unique opportunity to position Drexel as a leader in translational research around smart textiles.

Within four years, the single-machine operation had grown into Drexel's 2,000-square-foot Center for Functional Fabrics and researchers from across the University were joining Dion to explore the challenges and possibilities of textile technology. The collaboration produced ventures into everything from conductive yarn and fabric antennas to touch-responsive material and a computer program for designing and modeling the performance of advanced textiles.

Drexel's focus on commercializing its research, coupled with its record of forming productive collaborations, caught the attention of the Department of Defense as it was building up a national initiative to spur innovation in manufacturing. In 2016 the government invited Drexel to join its Advanced Functional Fabrics of America (AFFOA) — a \$75-million public-private partnership consortium made up of government, industry and academics — and Drexel set about transforming its Center for Functional Fabrics into a

THE DIRECTOR /// Geneviève Dion's fabric innovation center helps manufacturers prototype new textile products and smart fabric designs, and is supported by state and federal efforts to give American manufacturing an edge in high-tech textiles.

COMMUNITY MASK /// Below: At the start of the pandemic, the center created this Drexel Community Mask, based on a Shima Seiki pattern. The masks were optimized for reusability, fit and comfort and widely distributed to the Drexel community.

understanding these four fibers," Dion says. "Now, there are many new materials enabling functional fabrics. And when you want to make a device with new functionality or performance, it requires precision and repeatable manufacturing, so you need to fully understand a textile's behavior — right down to the fiber level."

So, one of the center's basic research pursuits is understanding and quantifying fibers and textiles in the same way engineers study the mechanical properties of structures like I-beams.

The center's textile testing and characterization facility is helping the team uncover and compile this important information. In it, researchers like textile engineer Chelsea Amanatides can twist, bend, pull and rub textiles until they break — all the while microscopically observing their behavior. This data, combined with many years of information on samples, prototypes and yarn, is bolstering a database that Dion says will guide and enrich the center's work.

The next task the team has undertaken is developing a design platform that can accurately model the behavior of textiles *before* they're created — allowing manufacturers to minimize the need for trial and error when innovating new products.

In collaboration with David Breen, a professor of computer science in Drexel's College of Computing & Informatics, the center is creating a data-driven fabric simulation tool. Breen's background in cloth modeling and animation began in the 1990s with doctoral research, conducted with the Fashion Institute of Technology, that supported the fabric composite design efforts of helicopter-maker Sikorsky Aircraft. Now he's using Amanatides' foundational research to build a predictive modeling tool for knitted textiles, similar to those used by architects and engineers to envision and examine the behavior of solid structures.

The team, which also includes Randall Kamien, a physics professor with the University of Pennsylvania, has already made strides in identifying appropriate geometric structures to represent yarns within a textile, resulting in an initial patent application. This step will simplify the modeling computation and will enable rapid simulation of the internal complexity that dictates a textile's behavior.

regional hub for studying, developing and commercializing textile technology.

Rising to the challenge once more, Dion and a team of partners from around the University, including President John Fry and Executive Vice Provost for Research & Innovation Aleister Saunders, added local and regional economic development funding to the University's own investment and began renovating a 10,000-square-foot lab in the heart of Drexel's Schuylkill Yards innovation neighborhood in West Philadelphia.

In the fall of 2019, Drexel opened its new Center for Functional Fabrics, a \$7 million end-to-end research and development facility supported in part by the Commonwealth of Pennsylvania, and the home of the Pennsylvania Fabric Discovery Center (PA FDC).

"The center's unique positioning at Schuylkill Yards highlights Drexel's vision to be an intersection of innovation, where researchers, startups and companies gather to revitalize Philadelphia's economy," Saunders says. "It places the Center for Functional Fabrics right at the forefront of advanced manufacturing of functional fabrics."

The center combines textile design and fabrication expertise with the ability to simulate a mass-production environment. It is built to explore new ideas, give them form and function and help others see the vision for their use. According to Stephen Luckowski, program manager for the Department of Defense's Manufacturing Innovation Institutes, which includes AFFOA, these centers are intended to bridge what startup investors call "The Valley of Death" — the daunting and expensive prototyping, validating and problem-solving process that lies between promising concept and viable product.

A primary challenge in that process that the CFF team has been addressing stems from the fact that textile making — though one of civilization's oldest forms of manufacturing — lacks the digital design tools to satisfy the technical requirements of functional fabric innovation.

"Up until 100 years ago, you only had four materials involved with textile making — its whole history was



LIFI HEADPHONES /// This knit headphone case is inlaid with monofilaments that enable wireless communication using infrared and visible light spectrum for high-speed data communication. When the monofilaments are exposed to the light spectrums, audio plays through the headphones. The monofilaments also protect the device from electromagnetic interference common in aircrafts, hospitals and military settings.



“Once you understand how the yarns work, you can build layers of abstraction upon that,” says Breen. “If we can model the yarns, we can then derive higher-order models based on that yarn structure.”

Addressing these fundamental challenges will eliminate a lot of the uncertainty from the innovation process and make it more accessible, and it could enable greater advances. Until the work is complete, however, researchers at the center are offering their experience in product design, prototyping and computer-aided manufacturing to support partners in industry, government and academia.

“As an industry person, partnering with Drexel is beneficial because I get to leverage their technology, and their knowledge of that technology,” says Eric Spackey, CEO of partner company Blue Water Defense and former chief marketing officer of AFFOA. “I may not have that same equipment, or I may not have the people who know how to run it. So, I can actually run concepts through them — to say ‘Hey, would this work? Could you make this material so it’s thinner, lighter, stronger, than I can on my current equipment?’”

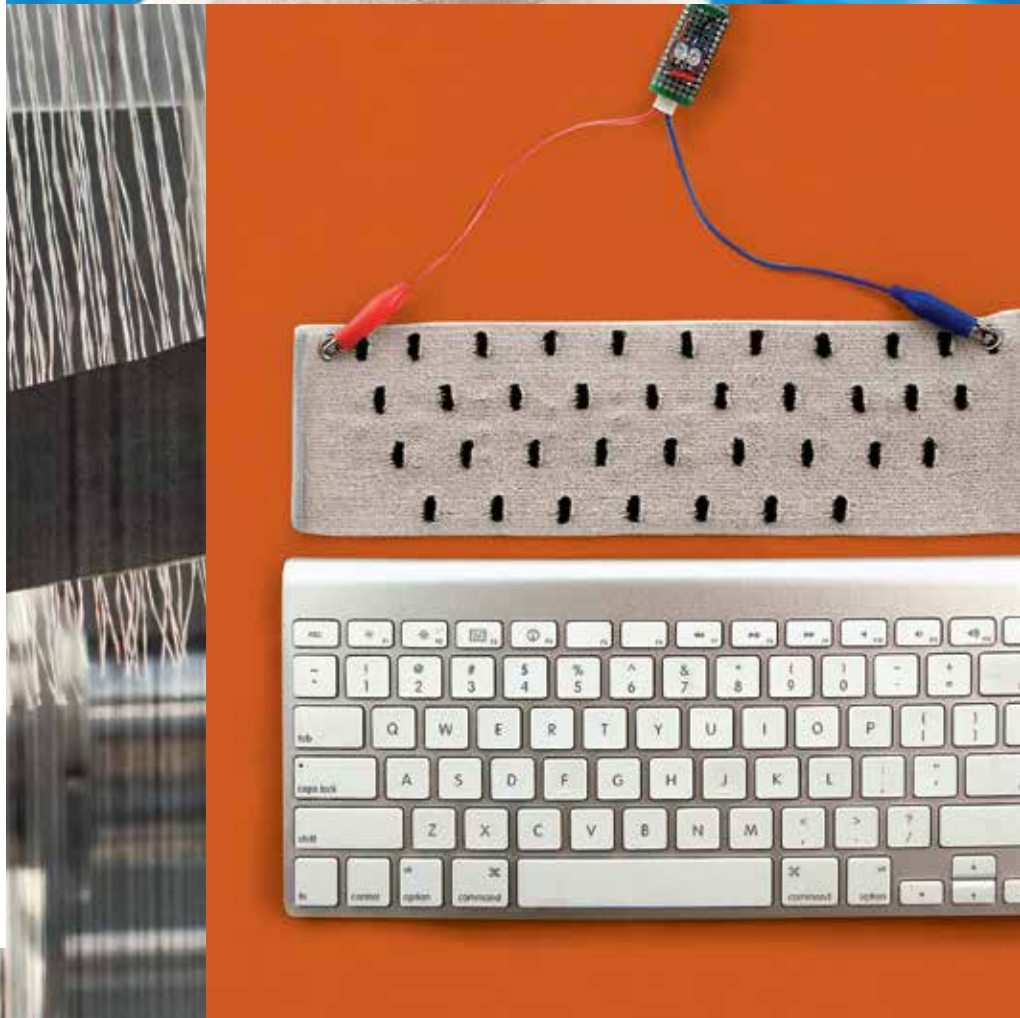
With its extensive background in textile technology, Drexel is well-equipped to take on prototyping challenges, owing to Dion’s initial decision to work with weft-knitting machines in her lab.

Weft machines are known for being a bit more user-friendly than other textile manufacturing equipment, making them well suited for rapid prototyping and research and development. As a result, weft knitting has emerged as a promising technology for advanced textile research, and it is now a staple in leading functional fabric labs across Europe and Asia. Drexel’s center houses seven of them, along with a complement of other textile manufacturing equipment, including weaving and warp-knitting machines.

It’s the closest textile-making analog to 3D printing, according to Stephanie Rodgers, director of Advanced Product Development at corporate partner Apex Mills, a specialty textile manufacturer in Graham, North Carolina. Just as a 3D printer extrudes its filament material to form a complete structure, a weft machine can knit a complete textile structure using a single strand of yarn. This means it is possible to fully control the architecture of a textile and to quickly produce small prototypes for testing.

“There is a real advantage to using weft knitting in developing technical textiles,” Rodgers says. “When you’re working with expensive, specialty yarns and you’re not entirely sure the prototype will work, or if the client will like it, you want to be able to iterate quickly on a small scale and without much material waste.”

Creating prototypes without a cut-and-sew step also benefits innovators looking to use electrically conductive yarns to add specific functions to textiles.



“The practical advantage of this is very big, because there is a strong necessity to minimize the number of conducting strands in your device, so that you can simplify the connection of the textile to a conventional electronic circuit,” says Alexey Melishchuk, associate director of licensing in Drexel’s Office of Research & Innovation, who is responsible for managing the intellectual property created at the center.

“People come up with all varieties of buttons and connecting clips and post-processing steps,” he says, “but it’s done in a bulky and clumsy way that’s inconvenient and not as robust. Having a single conductive strand passing through the entire garment allows you to have a complete electrical circuit and to do things like turn the garment into an antenna or connect it to software that can determine where on the garment you touched it.”

Drexel’s homegrown capacitive touch sensor (CTS) technology, which capitalizes on weft knitting for its functionality, is one of the team’s promising innovations. The fabric was initially developed by doctoral researcher Richard Vallett as a control system for humanoid robots. Through iteration and ongoing collaboration with Ali Shokoufandeh, a professor in Drexel’s College of Computing & Informatics, it has evolved into an internet of things–style touchpad kit. Textile engineers at the center have already used it to make a keyboard, a game controller and a trackpad.

Dion saw the CTS as a technology that could help people understand the possibilities of functional fabrics. At Apex Mills, Rodgers, who was helping the company and its clients capitalize on fabric technology, also recognized the potential of the CTS as a proof-of-concept. She quickly connected with Drexel to translate it into a form factor that is warp-knit — another type of high-volume knit fabrication that is featured in Apex’s operation.

After Drexel’s initial weft-knit CTS patent, and a year of iteration and modification, Drexel and Apex Mills applied for a patent for the warp-knit technology and are integrating it into clothing, furniture and transportation as a remote-control system. Both the technology and the collaboration have been held up as a proof-of-concept throughout the AFFOA network.

The collaboration that produced the CTS exemplifies the transdisciplinary nature of the center’s work, according to Dion. Projects typically involve a large team, with academic researchers at Drexel and elsewhere, and with industry partners, like Apex Mills.

“Before joining AFFOA, the Center for Functional Fabrics had a core competency in knitting and structures and integrating conductive fiber into a knitted structure — critical competencies to allow us to make smart textiles,” Luckowski says. “We didn’t explicitly have that capability at the headquarters, so we were looking to enhance our capability through regional strengths and also adding competencies we didn’t have somewhere else in the enterprise.”

Conductive fiber and yarn are key to expanding the capabilities of wearable technology, including devices that can monitor the health of the wearer, transmit information

CTS KEYBOARD /// The Capacitive Touch Sensor (CTS) is a flexible cloth touchpad interface that can be incorporated into physical devices (for example, it can be woven unobtrusively into a couch). It was produced as a single piece of fabric with carbon-embedded nylon for the touch sensors, and attaches to a microcontroller using just two electrodes.

KNIT CAPABILITIES /// The Pennsylvania Fabric Discovery Center’s expertise extends beyond flat weft knitting with machines such as the Lonati circular weft-knitting machine, which can rapidly prototype tubular forms like this knit iteration of a shoe upper.



and communicate with other devices. But Dion emphasizes that the true test of any wearable technology is its ability to go unnoticed in everyday garments. For this to happen, the conductive fibers that comprise them must be sturdy enough to survive the knitting process, in addition to regular wear and tear.

Over the past several years, the team has been working with Drexel materials science researcher Yury Gogotsi to knit supercapacitors using yarn coated with a conductive material, called MXene, discovered in Drexel’s College of Engineering. Dion and her doctoral students explored various methods of modifying traditional processes to create MXene yarns that could not only provide the required electrical properties for smart textile applications, but also withstand the industrial knitting process.

The ultimate goal of all of these collaborations is to build a portfolio of next-generation innovations that can revive America’s domestic manufacturing economy and create new jobs. Manufacturing based on proprietary or highly technical textiles would restore resiliency to the country’s industrial production base and protect it against the type of supply chain chasms it experienced with personal protective equipment manufacturing during the pandemic, according to Luckowski.

“The pandemic was definitely a wake-up call,” he recalls. “A silver lining is that people now recognize that if you can’t make it, you can’t have it. When you have a new model like this, you’re never done explaining it to people — some people need to see that tangible evidence, otherwise, it’s just an abstraction.”

In the midst of the pandemic, the Center for Functional Fabrics proved its model can deliver.

Dion was able to reopen the center, initially shuttered by statewide lockdowns, as part of the relief effort. Within weeks, her team revamped its prototyping setup, turning it into a mask-making operation. Within the first three months, they had churned out 12,000 cloth masks for local frontline workers and community members. The center also created a filtration-testing operation with College of Engineering Professor Michael Waring for the ongoing development of respirator masks and personal protective equipment, as part of a larger AFFOA COVID-19 response effort.

“Advanced manufacturing is very important because it may give us the opportunity to be able to pivot during difficult times,” says Dion. “That’s one of the things I always wanted the center to be about.”

Since her days as a bespoke fashion designer, Dion has demonstrated the vision to bring abstract ideas into reality. In the Center for Functional Fabrics, she has produced a prototype that might be just the thing to help others see the way forward.

THE EVER-EXPANDING APPLICATIONS OF MXENES

A decade after Drexel researchers invented a tiny 2D material called MXene, its potential for engineering novel materials and applications has only increased — even in a pandemic.

IN 2011, RESEARCHERS in Drexel’s Department of Materials Science and Engineering discovered an atoms-thin, two-dimensional material that has since transformed the field of 2D materials and, potentially, may change the way we live and use technology.

The material, dubbed MXene — pronounced “Maxine” and named for its chemical shorthand (“M” for metal, like titanium, and “X” for carbon and/or nitrogen) — was discovered by Drexel’s Distinguished Professor Michel Barsoum and Distinguished University and Charles T. and Ruth M. Bach Professor Yury Gogotsi. A decade ago, they were working on a Department of Energy (DoE) grant to make electrode materials for batteries, and created something unique when they added hydrofluoric acid to MAX phases, which are highly conductive layered materials with ceramic and metal properties that Barsoum developed in the late ‘90s.

Since then, their research teams have created and/or discovered several dozen different types of MXenes (depending on the type of MAX phase and etchant) and have studied the different properties of many of those new materials.

These MXenes remain highly conductive when applied in a variety of forms (everything from spray-paint to ink). This versatile and groundbreaking attribute solved the problem they were working on (improving energy storage), but also opened a whole world of possibilities to explore and answer. With MXenes, electronics could be made both smaller and faster; batteries could be made more long-lasting; wearable technology could become an everyday habit; pure hydrogen could be produced in a more efficient and cost-effective way; sensors detecting chemicals in the air could be improved; and a wearable kidney could be made to replace immobile, time-consuming kidney dialysis machines, among many other possibilities.

Researchers around the world are now studying this family of materials and hundreds of international and U.S. patent applications have been filed. Drexel’s MXene patent portfolio now includes 12 issued U.S. patents and two dozen invention disclosures received across the United States, Europe and Asia, covering core MXene composition of matter, formulations, methods of manufacture and various applications and systems. An additional 36 patent prosecutions (including provisional patent applications) are ongoing, and there are five licenses for exclusive commercial fields of use (electronics and biomedical applications) or for R&D distribution with materials suppliers. Currently, the University is working with several dozen companies to evaluate other MXene applications.

“It is very exciting to see MXenes take the world by storm,” Barsoum reflects. “The science behind them is fascinating and will more likely than not lead to some major breakthroughs. This is especially true given the extraordinary number of potential applications being explored — from energy storage to curing cancer to electromagnetic interference shielding, among many more.”

In 2020, MXene research and scholarship continued despite the COVID-19 pandemic, and a planned international conference in August transformed into an even bigger and more open virtual conference. Barsoum and Gogotsi organized and chaired the “MXenes 2020” three-day event that remotely brought together about 2,500 registered participants from more than 60 countries, which was preceded by a week-long course on synthesis and characterization of MXenes for about 60 students from around the world. Gogotsi plans to offer this course again in 2021 to American and international audiences.

And this year, as in years prior, Gogotsi, Barsoum and other Drexel researchers worked on a variety of MXene research projects that are expanding the field of MXene applications. Following are just a few examples. —Alissa Falcone

01 BLOCKING INTERFERENCE

Titanium carbonitride, part of the MXene family, has the ability to both block and absorb electromagnetic interference (EMI) better than any known material — even the metal foils currently used in most electronic devices. You’ve probably noticed EMI as the annoying buzzing noise from a

microphone or speaker, but EMI is a serious concern due to its ability to diminish electrical performance, slow data exchange rates and even interrupt the function of devices. EMI can be contained and deflected by covering the entire circuit board with a copper cage or by wrapping individual components in foil shielding, but researchers at Drexel and the Korea Institute of Science and Technology found that titanium carbonitride is just as effective, and thinner and lighter too.

“This discovery breaks all the barriers that existed in the electromagnetic shielding field. It not only reveals a synthetic inorganic shielding material that works better than copper, but it also shows an exciting, new physics emerging, as we see discrete 2D materials interact with electromagnetic radiation in a different way than bulk metals,” says Gogotsi.

Moreover, Gogotsi’s group has known that MXenes not only have the ability to block electromagnetic interference better than other materials, but also effectively adhere to fabrics and maintain their unique shielding capabilities when incorporated into textiles. As a result, titanium carbide-coated fabric can protect people and their gadgets from microwave radiation.

02 NO WATER, NO PROBLEM

“Water has been used in the MXene-making processes to dilute the etching acid and as a solvent to neutralize the reaction, but it is not always desirable to have traces of it in the finished product,” says Barsoum. “We have been working for some time to explore other etchants for the MAX phases and now we have found just the right combination of chemicals to do it.”



Barsoum and other Drexel researchers found a way to remove water from the MXene-making process, making the 2D materials ideal for creating battery electrodes, next-generation solar cells and other applications where the presence of water could degrade performance.

In the past, MXenes were produced by using a concentrated acid to carve away atomic layers from a MAX phase material, then washing that out with water to create flakes of the 2D-layered material. Now, a solution made of organic solvent and ammonium dihydrogen fluoride — a chemical commonly used to etch glass — does the same, but without water to dilute it or to wash away

the by-products. So not only can MXenes be used for applications that could be hindered by any added water, but it can be added to materials that would degrade in water.

03 MAKING MORE MXENE

Only a handful of 2D materials have the potential to be produced in industrial-size quantities — and now, MXenes are one of them. Drexel researchers working with the Materials Research Center in Ukraine developed a way to make MXenes in batches large enough to be considered viable for manufacturing, while still preserving the material’s unique properties.

This is hugely attractive for companies wanting to develop applications of MX-

ene materials, and reaching manufacturing standards is one item to be checked off the “to-do” list for mainstream use of MXene.

“Proving a material has certain properties is one thing, but proving that it can overcome the practical challenges of manufacturing is an entirely different hurdle — this study reports on an important step in this direction,” explains Gogotsi. “This means that MXene can be considered for widespread use in electronics and energy-storage devices.”

04 SEE THE LIGHT

Photodetectors convert information carried by light into an electric signal that can be processed by electronic circuits and computers — a useful application

for everyday devices like television remotes, and one that has unlimited potential in sensing, artificial intelligence, Internet of Things (IoT), and optical data storage.

It’s no wonder, then, that the photodetector is such a high-demand product, but it’s also a costly one. Expensive materials like gold and titanium are needed to fabricate them in highly controlled conditions produced by capital-intensive equipment. Drexel researchers found that replacing gold with a transparently thin layer of MXene material can scale up the photodetector production process and churn out sensors that are superior (and less costly) compared to the, ahem, gold standard.

05 READY FOR 5G

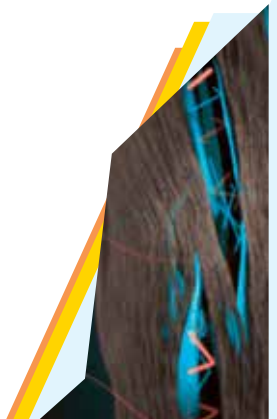
Drexel researchers created new antennas made of MXenes that are thin enough to spray-on, but also strong enough to send a signal at bandwidths that will be used by fifth-generation (5G) mobile devices. This has promising potential for the future of telecommunications and 5G technology, but also shows that MXenes can be spray applied, screen printed or inkjet-printed onto just about any substrate and remain flexible without sacrificing performance.

“This combination of communications performance with extreme thinness, flexibility and durability sets a new standard for antenna technology,” says Gogotsi. “While copper antennas have been the best in terms of performance for quite some time, their physical limitations have prevented connected and mobile technology from making the big leaps forward that many have predicted. Due to their unique set of characteristics MXene antennas could play an enabling role in the development of IoT technology.”

06 MXENE AS CATALYSTS

“Efficient catalysts are crucial for reducing energy consumption in the manufacturing of many chemical reagents and for the electrolytic production of hydrogen from water,” Barsoum says, and MXene and its composites can be used as promising catalysts in different reactions.

Drexel and French researchers reacted MXene powders with sulphur to form a catalyst for hydrogen evolution that’s almost as good as carbon-platinum, one of the best-known catalysts for this reaction.



← MXene absorbing EMI



← MXene antenna for 5G devices

NEW SPECIES

CREATURES, GREAT AND SMALL

Scientists from the Academy of Natural Sciences are continually identifying new species and expanding our knowledge of biodiversity with their discoveries.

EACH YEAR, scientists from the Academy of Natural Sciences of Drexel University work to bridge the gap between the known species on our planet, and the millions still left to identify.

Here are some recent discoveries newly entered into the scientific record, from a super-powered electric eel that is not actually a true eel, to other fish, algae, mollusks and diatoms.



Megalichthys mullisoni

01 OLD AND GONE Fossilized jaw from a newly described ancient fish.

02 AMAZONIAN A new species of tiny bivalves discovered in Amazon River tributaries.

Rheodreissena cordillineata



Tamilokus mabinia

03 UNUSUAL Unique wood-boring bivalve.



Leatettix cowperi

04 JUMPING New South Africa grasshopper species.



An electric eel with a view of its oral respiratory organ. Electric eels are obligate air breathers.

05 SHOCKING

01 Jason P. Downs, a research associate at the Academy, and Ted Daeschler, professor in the Department of Biodiversity, Earth & Environmental Science in the College of Arts and Sciences and curator of Vertebrate Zoology at the Academy, recently described a new species of lobe-finned fish from the Late Devonian (Famennian) in Pennsylvania. Pictured here is fossil material of the lower jaw.

02 Academy Interim Curator of Ichthyology Mark Sabaj is credited with discovering two new species of minute bivalves from the rapids of clearwater tributaries to the lower Amazon River. Despite their small adult size (less than 1.5 centimeter in length), females brood young and release spawn into the environment as tiny, shelled juveniles less than 1 millimeter long. The two new species belong to the same family as the zebra mussel (Dreissendae), a species native to Europe and widely invasive in United States.

03 Gary Rosenberg, professor in the department of Biodiversity, Earth & Environmental Science and Pilsbry Chair of Malacology at the Academy of Natural Sciences, was part of a team that described a new and anatomically divergent genus and species of wood-boring bivalve (Teredinidae) from the Philippines, named Tamilokus mabinia. Specimens were collected off the coast of Mabini, Batangas, Philippines, from sunken driftwood.

04 Academy researcher Daniel Otte has dedicated his time and study to the construction of a complete accounting of the South African grasshopper fauna. In March 2020 he published a progress paper in Transactions of the American Entomological Society on the taxonomy of eleven genera in the grasshopper family Lentulidae from South Africa. It outlines over 30 new species credited to the work of Otte, who is a professor emeritus in the College of Arts and Sciences and senior curator emeritus for the Academy.

05 A team of ichthyologists including Mark Sabaj discovered and described two new species of electric eel, including one that can discharge up to 860 volts of electricity, making it the strongest living bioelectricity generator. This is significantly more than the 650 volts previously recorded for the electric eel, which was thought to include but one species...until now.

HABITATS

CHEMISTRY

BIOCHEMISTRY

AIR QUALITY

NEW SPECIES

ENCROACHING ON THE ENDANGERED



JAMES SPOTILA Spotila is emeritus L.D. Betz Chair Professor of Environmental Science in the Department of Biodiversity, Earth, and Environmental Science in the College of Arts and Sciences.

BEFORE CHINA declared giant pandas a protected species in 1962, hunters used dogs to pursue them. But more than half a century later, dogs are still jeopardizing their safety, according to a team led by the L.D. Betz Chair Professor James Spotila.

His group began to investigate the problem after two captive-born pandas, which they had previously released into Liziping Nature Reserve, were attacked by dogs.

DOG RUNS

Free-roaming dogs threaten pandas' territory in Liziping and Daxiangling Nature Reserves in China. Researchers surveyed six village groups surrounding Liziping in 2017 and found that 212 of the 334 (64 percent) owned dogs in those villages were free-roaming, and that 38 percent of owned dogs in Daxiangling were free-roaming.

Pandas are a vulnerable species in part because they require a minimum habitat size of 114 square kilometers to thrive. While most nature reserves designated for giant pandas are sufficiently large, encroachment by free-roaming dogs could significantly limit the bears' territory.

The research team, working out of Chengdu Research Base of Giant Panda Breeding, analyzed all giant panda reserves in China and found that across the entire range, 40 percent of panda habitats are within range of roaming dogs. As a consequence, the area safely available for giant pandas in nature reserves throughout China is only 60 percent of the official "protected" area.

In their report in Scientific Reports, they recommend a comprehensive approach to dog-control efforts by local governments that includes licensing, collaring and education for residents.

"Only by understanding and managing complex interactions between humans, domestic animals and wild animals can we sustain natural systems in a world increasingly dominated by humans," Spotila says.



BLASTED CHEMICALS

Researchers are showing that cold plasma can eliminate persistent toxins called "forever chemicals" from food and water supplies.



What are "forever chemicals?"

PFAS stands for per- and polyfluorinated substances, a group of chemicals used to make coatings and products that resist heat, oil, stains, grease and water, such as common household non-stick cookware, adhesives and food packaging. They are concerning because they persist as contaminants in the food chain.

A LARGE CLASS OF stubbornly resilient toxic compounds, ominously dubbed "forever chemicals," persist in the drinking water of millions across the United States and have been detected in the bloodstream of as much as 98 percent of the population. These harmful man-made contaminants are hypothesized to be linked to problems such as cancer, thyroid problems, low birthweights and high blood pressure.

Associate Professor of Environmental Engineering Christopher Sales is part of a team from the

DIZZYING EFFECT

Pictured is a spinning vortex of plasma. Drexel researchers have shown that a vortex of cold plasma can eliminate PFAS compounds from water.

College of Engineering and the C. & J. Nyheim Plasma Institute exploring how a blast of charged gas, called cold plasma, can be used to eliminate per- and polyfluoroalkyl substances, commonly called PFAS.

To create cold plasma, an electromagnetic field is used to excite the electrons in a gas without raising its

overall temperature. Turning it loose on the PFAS is the chemical equivalent of using a blender to make a smoothie, as it ultimately creates a spinning vortex of atoms, ions and radiation, which can reach a level of activity high enough to sever the carbon-fluoride bonds in the PFAS compounds.

"This is just one example of how effectively and efficiently cold plasma technology can be used to address difficult chemical contamination problems," says Alexander Fridman, director of the C. & J. Nyheim Plasma Institute.



BACTERIAL PREVENTION

Tiny bacteria could soon be chipping in to keep roads from chipping away in the winter.

COMPOUNDS LIKE calcium chloride — commonly called "road salts" — are commonly used to prevent ice and snow on winter roads. But road salts also cause potholes and road surface deterioration, because the chemicals react to form an expansive compound called CAOXY — short for calcium oxychloride — that can break down concrete by generating internal expansions and distresses.

Three researchers in Drexel's College of Engineering — Yaghoob Farnam, Christopher Sales and Caroline Schauer — have discovered how mixing a bit of bacteria called Sporosarcina pasteurii into concrete can reduce the formation of CAOXY.

Over the past decade bacteria like S. pasteurii have been studied as a way to repair cracks in statues and concrete infrastructure, and, more recently, as an environmentally sustainable option for making bricks.

But the Drexel researchers realized that one of the bacteria's other talents might also be quite useful for preventing those

cracks from forming in the first place.

To test their theory, Sales and Farnam made a series of concrete samples using the type of cement commonly used in roads and added a mixture of S. pasteurii with the nutrients they need to survive.

The concrete mixed with the bacteria experienced almost no deterioration after exposure to the calcium chloride. In addition, the levels of CAOXY were much lower in the bacteria-laden samples, as a result of the microbial-induced calcium carbonate precipitation. The presence of calcium carbonate suggests that the bacteria's interaction could also be used to strengthen the road surface, though this application would require more research, according to the team.

"The bacteria are capable of changing the micro-environment around them to create conditions to heal micro-cracks in the concrete," Sales concludes.

SALTY CONSEQUENCE

Road salts damage concrete by forming a chemical, called CAOXY, that causes cracks to form and wedge apart. Adding bacteria to the mix could prevent CAOXY from forming.



COURTESY GREG FRIDMAN

PURE MYTH

POTTED PLANTS ARE lovely, but claims about their ability to purify indoor air are vastly overstated, according to research from Drexel's College of Engineering.

Professor and Civil, Architectural and Environmental Engineering Department Head Michael Waring and a doctorate student reviewed a dozen studies, spanning 30 years of research, to draw their conclusion that natural indoor ventilation dilutes concentrations of volatile organic compounds much faster than plants can extract them from the air.

"This has been a common misconception for some time," says Waring. "Plants are great, but they don't actually clean indoor air quickly enough to have an effect on the air quality of your home or office."

The origin of this myth seems to have stemmed from a NASA-funded study in 1989 which declared that plants could be used to remove cancer-causing chemicals from the air in space stations.

The problem with this experiment, and others like it, is that it was conducted in a sealed chamber in a lab with no natural or ventilated air exchange.

According to Waring and Cummings's calculations, it would take between 10 and 1,000 plants per square meter of floor space to compete with the air cleaning capacity of a building's air handling system or even just a couple open windows in a house.

"This is certainly an example of how scientific findings can be misleading or misinterpreted over time," Waring says.

A ROCK-SOLID RARITY



A microscopy image of a nearly 4-inch Lithoredo abatanica shipworm.



GARY ROSENBERG Rosenberg is a professor in the Department of Biodiversity, Earth and Environmental Science for the College of Arts and Sciences, and curator and Pilsbry Chair of Malacology in the Academy of Natural Sciences of Drexel University.

MOST SHIPWORMS feed by, as their name suggests, boring into and digesting wood with the help of symbiotic bacteria that live in their gills.

But a team of scientists unveiled a new and very different species of shipworm, Lithoredo abatanica, which is unique. It actually eats rock as it burrows, expelling sand as feces. And it appears to exist only in one river in the Philippines.

Gary Rosenberg, professor in the College of Arts and Sciences and curator and Pilsbry Chair of Malacology in the Academy of Natural Sciences of Drexel University, was part of a team led by researchers at Northeastern University that examined and described this new anatomically and morphologically divergent species of shipworm.

The species was first

"What we didn't expect is just how bizarre the animal turned out to be."

found by a French expedition in 2004 in a freshwater habitat in the Abatan River in the Philippines. The current research group decided to return to the river site in 2018. They found this new genus about two kilometers upstream from the French site, after receiving a tip-off from locals about a rock-eating clam.

"What we didn't expect is just how bizarre the animal turned out to be," says Rosenberg, who says this discovery exemplifies the need to preserve and protect our biodiversity. "... How could such an amazing animal have been overlooked for so long?"

RENEWABLE ENERGY

_ GREEN FEES

As the Rocky Mountain region plans its energy future, one study suggests that **shifting power production from fossil fuels to renewable sources could save society at least \$1 billion.**

RESearch by Drexel and the University of Colorado at Boulder suggests that imposing fees on energy producers that emit greenhouse gas could improve the health and financial well-being of the Rocky Mountain region.



_ SHANNON CAPPS Capps is an assistant professor in the Department of Civil, Architectural and Environmental Engineering in the College of Engineering.

The team used sophisticated modeling programs that estimate atmospheric concentrations of ozone, a ground-level pollutant, by considering factors like current emissions from power plants, weather trends and changes in energy production. They compared the effects of proposed production policies of three scenarios in the Rocky Mountain region with the current status quo.

The 2030 baseline scenario includes planned transitions away from coal-fired power plants and toward natural gas extracted from new sites in the region.

Two scenarios evaluate possible economic drivers of

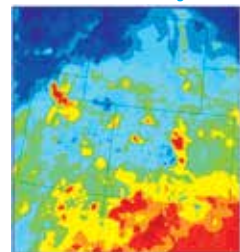
energy production in 2030 — cheap natural gas or fees on greenhouse gas (GHG) emissions. The first scenario considers the effects of lower costs of energy production from natural gas. The second scenario considers the possibility of fees being imposed on the producers of greenhouse gas — a policy that has been proposed by current proponents of the Green New Deal.

Their research predicts that planned regulations on energy production by 2030

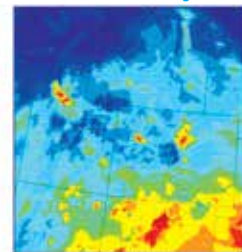
would prevent about 200 people from dying early due to exposure to ozone and would reduce GHG emissions by 4 percent, saving society about \$2.2 billion annually. If, however, natural gas becomes even more ubiquitous as an energy source in 2030, these societal savings would be reduced by about 20 percent. However, with greenhouse gas fees, at least \$1.2 billion in additional societal benefit would accumulate due to 10 more premature deaths being prevented and a nearly 30 percent decrease in emissions.

“The current administration and Congress will continue to shape the future of energy production in the Rocky Mountain region as well as the entire United States,” says Assistant Professor Shannon Capps. “This study demonstrates that these decisions will have significant health and economic impacts.”

A: 2011 Baseline Hourly Ozone



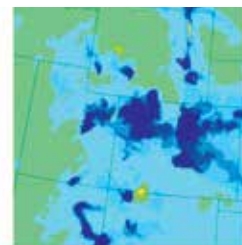
B: 2030 Baseline Hourly Ozone



C: 2030 Cheap Gas Scenario



D: 2030 Greenhouse Gas Fees



Map A shows hourly ozone levels across the Rocky Mountain states in 2011, while Map B predicts future ozone levels in 2030 under current energy policies. Map C evaluates how ozone could be impacted by 2030 in a scenario of cheap, widely used gas. By comparison, Map D models a scenario in which greenhouse gas emissions fees are imposed on energy producers. (Red indicates high ozone levels, with cooler colors indicating lower levels.)

CONSERVATION

_ MURKY WATERSHED OUTCOMES

More public and private resources than ever are being directed to **protecting and preserving aquatic ecosystems and watersheds** — but are they truly having an impact?

SCIENTISTS FROM the Academy of Natural Sciences of Drexel University have found evidence that although decades of watershed restoration and mitigation projects have taken place, data measuring their impact is relatively undocumented — or simply missing.

“There is no ‘one-size-fits-all’ approach to watershed restoration, but a framework that enables better planning, monitoring and management will help us better inform restoration.”

In an online article published in *Freshwater Science*, researchers from the Academy and the Stroud Water Research Center attribute the dearth of data to a need for greater investment in planning, goal-setting, monitoring and documenting stages of mitigation programs throughout the watersheds.

Stefanie A. Kroll, an assistant research professor in Drexel’s department of Biodiversity, Earth & Environmental Science and the lead author of the paper, encountered these challenges first-hand while working on The Delaware River Watershed Initiative.

To address these challenges, the authors suggest a combination of

setting clear standards for monitoring the programs and partnering with funders and established conservation groups to implement it.

“You don’t have to rebuild the wheel, to solve this challenge,” says Kroll. “There is no ‘one-size-fits-all’ approach to watershed restoration, but a framework that enables better planning, monitoring and management will help us better inform restoration — ensuring activities are achieving their intended benefits and ultimately improving water quality and preserving the integrity of our ecosystems.”

Kroll also co-authored a review that measured improvements from agricultural best management practices and found a wide range of effectiveness. The review is helping Kroll and her colleagues set targets for recovery of aquatic communities when such practices are implemented, and a forthcoming study will stress how equally important measuring change is when setting objectives for restoration projects.

Continuing to restore waterways is a very important activity, given all the stress our actions have put on them, and seeing the fruits of this labor may take decades, Kroll adds. But monitoring changes and developing data to set targets is important for being able to inform practitioners on what is most effective, and what changes might need to be made on these decades-old practices.

_ AN OUTPOST FOR EQUATORIAL GUINEA

Drexel is expanding a unique conservation, research and visitor outpost it operates on the island of Bioko in partnership with the Universidad Nacional de Guinea Ecuatorial.

LAST YEAR, a long-standing environmental research program that Drexel operates in Equatorial Guinea with the Universidad Nacional de Guinea Ecuatorial (UNGE) expanded its mission to further promote conservation and ecotourism on the country’s Bioko Island, home to animals like gorillas, chimpanzees, forest elephants and leopards.

The Bioko Biodiversity Protection Program (BBPP) program was founded by Emeritus Biology Professor Gail Hearn in 1998 and is now directed by Professor of Biology Mary Katherine Gonder, with involvement by Drexel students and volunteers.

In February 2020, a delegation of Drexel leaders met with members of the government of Equatorial Guinea to reaffirm the research partnership. One outcome of the visit was the establishment of the GENTE Consortium, a new Drexel program to advance solutions in higher education, environmental conservation, and public health for the benefit of the people of Equatorial Guinea.

The program will leverage the expertise of a growing network of partner universities and research institutions.

“This isn’t just about collecting knowledge for knowledge’s sake, but to improve the world,” says Executive Vice Provost for Research & Innovation Aleister Saunders, who was among the visiting delegates.



04 Golden Puddle Frog

01 Bioko Drill

02 Red-Bellied Paradise Flycatcher

03 Leatherback Turtle

The Ureca Nature Center, jointly managed by BBPP and the residents of Ureca village, serves as a visitor’s center, café, and retail store for local artisans.

BIOKO RESEARCH PRIORITIES

01 Primates

BBPP conducts surveys of the island’s primates to learn how to protect wild game species from the bushmeat trade and educates locals on the importance of biodiversity conservation.

02 Birds

BBPP’s efforts to monitor the island’s nearly 200 bird species are a core educational tool for the Drexel in Equatorial Guinea study-abroad curriculum.

03 Sea Turtles

BBPP seeks to improve and advance data collection on four species of sea turtles that nest on the island’s southern beaches.

04 Frogs

BBPP studies how microclimates and changing climate influences the formation of new and distinct species, using native frogs as a model.



The Bioko Island Book Series program educates local children on the importance of protecting the island’s sea turtle and monkey populations.

WHAT BBPP DOES

Bioko Biodiversity Protection Program’s mission is the conservation of Bioko Island’s wild spaces and biodiversity, especially its critically endangered species, through the development of economically self-sustaining programs. It is also the country’s only international study-abroad program.

_ORIENTATION, EXPLAINED

CAN YOU IMAGINE looking for a destination without a GPS, visual landmarks, or even street signs?

This is the reality for fruit flies, as they search for food or a mate. Researchers have uncovered different cues that influence these searches, but until now, haven't yet understood how individual directional cues and search movements are used together.

Findings from researchers in Drexel's School of Biomedical Engineering, Science and Health Systems provide clarity on how flies find food, and also may help answer broader questions about how the ways that insects and animals search for food influences broader food ecology and the environment.



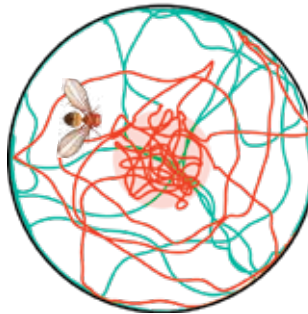
_VIKAS BHANDAWAT Bhandawat is an associate professor and Liangyu Tao is a graduate student in the School of Biomedical Engineering, Science and Health Systems.

The team converted the flies' olfactory nerve cells that usually respond to odors into light-sensing cells to detail the paths of flies as they find food, leave and attempt to return back to the food. To do this, the team projected light in a small region of a larger area to stimulate receptor nerve cells that control fruit flies' sense of smell.

The study showed how non-orienting movements, such as slowing down significantly and turning frequently to stay in an area, can be an effective mechanism for finding resources when directional cues are absent.

"Non-orienting movements are also found in expert navigators, such as desert ants. Once they are near their home, they depend on these movements to get there," says Associate Professor Vikas Bhandawat.

"One of the main take-aways here is that smell — as a sensation in the near past — is an effective sensory cue for flies, and likely many other animals," adds lead author Liangyu Tao, a graduate student in the School of Biomedical Engineering, Science and Health Systems.



LIGHT_SENSE

The diagram above depicts a fly's behavior in a small, circular arena. There is no light. Flies spend most of their time on the border and make occasional forays to the center (green lines). When a red light, which the flies cannot see but which activates genetically engineered olfactory neurons is turned on, flies think that there is an attractive odor in the center and start circling the center.

_ASHES TO CONCRETE

A new process developed at Drexel can convert tons of coal-fired power plant waste into a customizable and durable construction material.

TENS OF MILLIONS of tons of coal ash from power plants ends up in landfills each year. But researchers believe they have found a way to turn the waste into a special additive that makes concrete used in construction more durable and crack-resistant.

"Not only does this help protect our natural environment but it will also help to improve our built environment," says College of Engineering Assistant Professor and Principal Investigator Amir Yaghoob Farnam.



_AMIR YAGHOOB FARNAM Farnam is an assistant professor in the Department of Civil, Architectural and Environmental Engineering in the College of Engineering.

Concrete is one of the most widely used building materials in the world, but it requires just the right atmospheric conditions to allow proper mixing and even curing — not too hot, not too cold, not too dry.

Farnam's lab wanted to design an aggregate product that had optimal characteristics for mixing, strength and porousness — and find a way to make it out of an abundant waste material.

The material they came up with is called "spherical porous reactive aggregate," or SPoRA for short. It is made by combining the ash with chemicals that facilitate aggregate sinter-



SPoRA is an aggregate made from recycled coal ash derived from coal power plant waste. It's porous, lightweight and can be used as a concrete additive to aid the hardening process. The aggregate can be customized in various sizes and with pore configurations tailored specifically for improving concrete curing.

ing and bonding, forming them into tiny spheres and then baking them at 1,160 degrees Celsius for a few minutes. The end product is an aggregate pellet that can hold almost half its weight in water, which is better than traditional lightweight aggregates.

"The solution we came up with involved recycling this waste product, coal ash,

into a porous, lightweight aggregate with excellent performance characteristics that could be produced at a lower cost than current natural and synthetic options," Farnam says. "This material and process would not only benefit the concrete industry by improving the quality of their products, but it could also help keep coal ash out of landfills."

_STOP OZONE BEFORE IT STARTS

Atmospheric researchers believe hundreds of lives and hundreds of millions of dollars in crops could be saved with a minimal reduction of the key emissions that form ozone.

WHAT DO YOU get when you mix oxides of nitrogen, volatile organic compounds and sunlight? You get ozone, which harms people and plants. But, policies that limit these precursors could drastically reduce the formation of ozone, according to an international team of atmospheric researchers.

Shannon Capps, an assistant professor in Drexel's College of Engineering, led the team which traced the precursors of air pollution over space and time across the United States to understand why it forms where it does and what specific steps can be taken to curtail it.

in Chicago, St. Louis and Louisville, 10 percent reductions in VOC emissions would not only benefit the health of residents but also the productivity of surrounding soybean producers.

Nitrogen emissions played a larger role in affecting the productivity of plants and crops. For crops like potatoes, soybeans and cotton, a 3-4 percent loss in productivity due to ozone exposure could be reduced by about 5 percent with the prescribed 10 percent reduction of NOx emissions.

The group produced a map that shows where it is most advantageous to reduce VOC and NOx emis-

10%

Researchers found that by cutting oxides of nitrogen (NOx) and volatile organic compounds (VOCs) emitted by humans by just 10 percent, nearly 650 lives could be saved.

"Having a map of where marginal emissions reductions are expected to benefit human health and crop productivity greater than average is an important new development," Capps says. "For example, we found that by cutting oxides of nitrogen (NOx) and volatile organic compound (VOC) emitted by humans by just 10 percent, nearly 650 lives could be saved."

In urban areas, where NOx are present in high levels from vehicle fuel and exhaust, VOCs are the controlling factor for ozone formation. For instance,

sions. That is, where would a 10 percent reduction in NOx or human-produced VOCs benefit both human health and crop productivity while also helping states comply with the EPA's National Ambient Air Quality Standards? Such information has been hard for local regulators to find in the past.

"The tools that we used could be applied by local or state governments to determine how to efficiently protect both human health and crop productivity from ozone exposure," Capps says.

_WATER WOES

EPIDEMIOLOGISTS in the Dornsife School of Public Health have found an association between heavy spring rains in Philadelphia and an increase in acute gastrointestinal illnesses throughout the city.

To reach their findings, researchers studied rainfall over a three-year period from 2015-2017, with data combined from daily precipitation measurements taken at the Philadelphia International Airport, as well as precipitation modeled to watershed boundaries that serve Philadelphia's drinking water supplies. Acute gastrointestinal illness cases were tracked by the City of Philadelphia's syndromic surveillance system, which records city residents' reasons for visiting the emergency department.

They found that rates of acute gastrointestinal illnesses after spring deluges were more than double the average during dry spells, looking at a period starting one week after a heavy rainfall and persisting for 28 days.

The researchers speculate that heavy precipitation brings pathogens into stormwater runoff and local water supplies, and posit that exposure may occur either by direct contact with contaminated stormwater or through contamination of drinking water supplies.

"These findings indicate that investments...to manage stormwater better and protect the watershed are important for ensuring safe drinking water in our changing climate," says senior author Jerald Fagliano, an associate clinical professor and chair for Dornsife.

_MACHINES MODELED AFTER MAN



_AHMAD R. NAJAFI Najafi is an assistant professor in the Department of Mechanical Engineering and Mechanics in the College of Engineering.

A TEAM FROM Drexel University and North Carolina State University created a computer program that efficiently mimics the human body's evolution-optimized cooling system in functional materials.

"When you get hot, the body sends a signal to the circulatory system to pump more blood to the surface of the skin — this is why we sometimes get red in the face," says Ahmad Najafi, an assistant professor in Drexel's College of Engineering. "This is a natural method for dissipating heat that works so well, scientists and engineers have been trying for years to replicate it in mechanical cooling systems, like the ones that keep cars and computers from overheating."

Their computer program, coined HyTopS, which is short for hybrid topology/shape optimization, can produce a schematic for

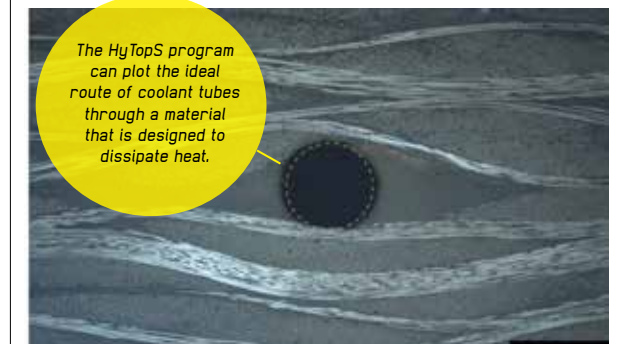
a vascular network with the ideal shape, size and distribution of micro-vessels to actively cool a material via liquid circulation.

Microvascular fiber-composites are currently being developed to cool everything from electric vehicles to next-generation aircraft, where increasingly higher performance is generating high heat.

To put their optimization method to the test, the researchers designed and built a microvascular carbon-fiber composite using 3D printing and tested its cooling abilities against a reference design from prior studies. After heating the carbon-composites to a maximum temperature, they pumped liquid coolant — similar to the stuff in your car — through each vascular network to begin the cooling process.

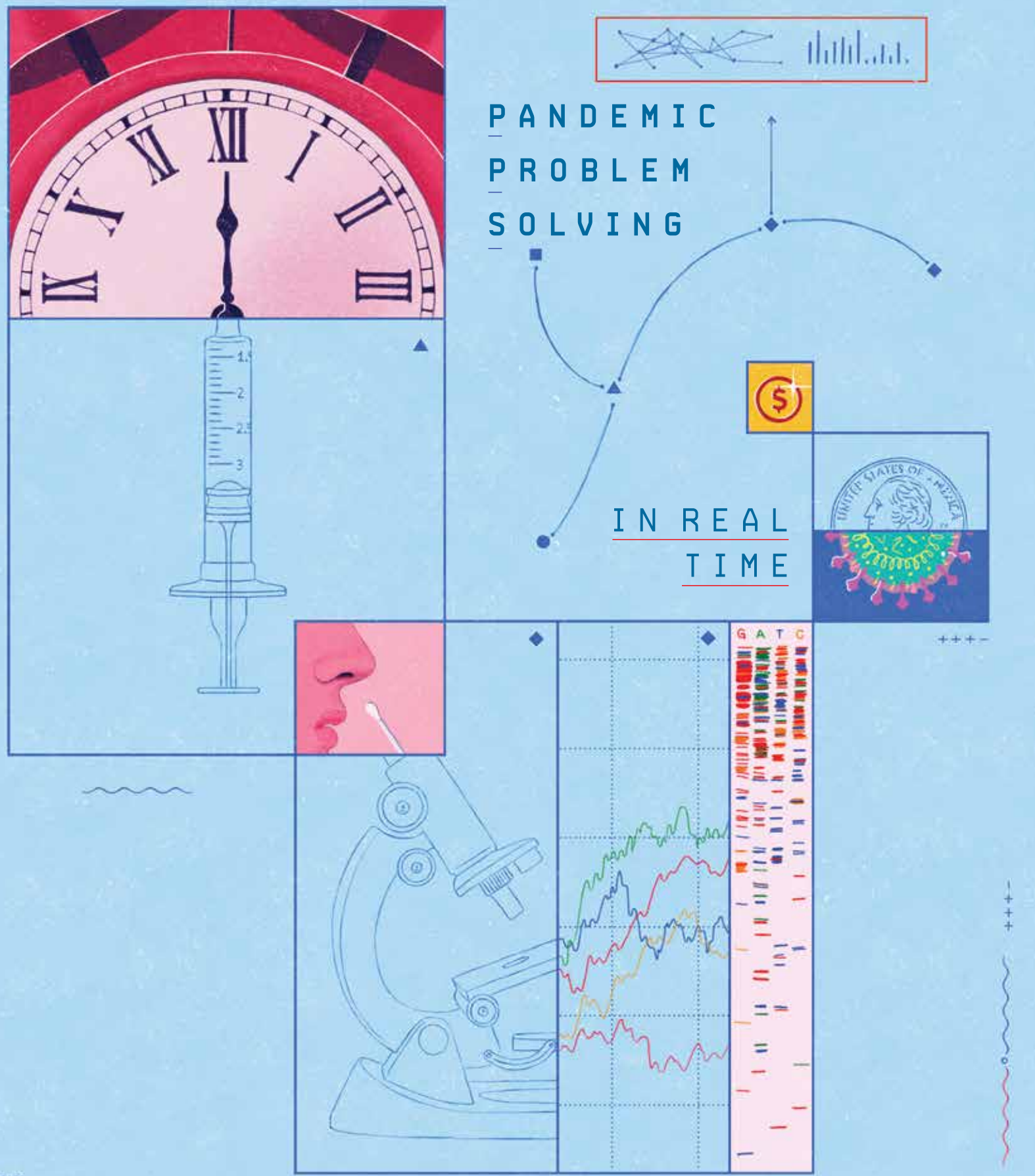
The HyTopS-optimized carbon-composite was not only cooler, but more uniform in terms of surface temperature distribution, and was able to cool down faster than the reference design.

"It's nearly impossible to reproduce the entire complexity of natural microvascular, but our program allows for a great deal of optimization input and considers manufacturing parameters to ensure the design can actually be constructed," Najafi says.



The HyTopS program can plot the ideal route of coolant tubes through a material that is designed to dissipate heat.

_ONLINE
The Dragon Seed fund supports "rapid response" research. Make a gift at bit.ly/3qDZBof.



THE PANDEMIC ARRIVED AT THE WORLD'S DOORSTEP IN 2020 DEMANDING OUR IMMEDIATE ATTENTION; THERE WAS NO IMMUNITY, NO TREATMENT, NO TIME TO LOSE. DREXEL RESEARCHERS ACTED FAST, SETTING TO WORK ON NEW DIAGNOSTICS, LIFE-SAVING EQUIPMENT AND A VACCINE - ALL FUNDED BY THE UNIVERSITY'S "RAPID-RESPONSE" APPROACH TO RESEARCH.

*_story by
Alissa Falcone*

*_illustrations by
Daniel Livano*

BY THE TIME THE pandemic reached Pennsylvania in early 2020, the novel coronavirus disease had already quarantined a large swath of China, swamped hospitals in Italy, and killed several Americans on the West Coast. The world knew almost nothing about how the virus functioned or how to fight it.

The scientific and medical community needed assistance, yesterday.

Fortunately, even before the pandemic, administrators in Drexel's Office of Research & Innovation had considered forming a seed fund that could quickly dispense research dollars to faculty working on short-term, rapid turn-around projects related to urgent social problems.

With COVID-19 as a catalyst, the seed fund quickly turned into reality. A citywide lockdown went into effect on March 20, 2020, putting Philadelphia on hold, shuttering buildings and sending everyone home indefinitely, but Drexel researchers marched into action, pivoting toward projects to tackle the challenges of COVID-19.

"Faculty were already emailing us mid-March saying, 'I'm working on this COVID-19 project, is there any funding?' We saw that there was a real challenge that the research community was reacting to, so we thought, let's do this as accurately and promptly as we can do it," recalls Executive Vice

Provost for Research and Innovation Aleister Saunders, who heads the Drexel Office of Research & Innovation.

Within days, the office announced the creation of the University's COVID-19 Research & Innovation Collaborative. In partnership with Drexel's Institutional Advancement arm, which raised \$125,000 from trustees, the office assembled \$175,000 to fund its first Rapid Response Research & Development Fund.

The fund was announced April 1. By the April 6 deadline, over 40 submissions were submitted.

Funds were soon awarded to 17 projects proposed by 35 faculty members (including some working on multiple projects) from nine different colleges and schools. The scope and size of the projects varied greatly, from creating personal protective equipment and diagnostic tests to developing therapeutics and vaccines, to studying the pandemic's social, economic and mental health impacts.

"We were able to be nimble, which is sometimes challenging when you're in a big bureaucratic institution," says Director of Research Strategic Initiatives Gwynne Grasberger. "It was not just about getting the money quickly; the researchers also had to produce something quickly."

A number of the projects have since grown in scope and gone on to attract additional external grants, just as the seed fund was intended to do. By the end of 2020, the projects had produced an additional \$2 million in grants, six patent disclosures and some 30,000 pieces of personal protective equipment. Several more grants are pending.

The success of the rapid response approach inspired the Office of Research & Innovation to do it again. In June, as social justice protests erupted against the killing of George Floyd by a police officer, the office awarded \$100,000 to faculty researchers working on topics related to race. The fund awarded 22 grants from 33 submissions to examine racial inequity, both on and off campus (see related story, page 64).

"This just reflects who we are at Drexel," says Saunders. "We attract faculty, students and professional staff who want to address society's most pressing challenges, and this year, we had unprecedented events in rapid succession. We were so inspired by that response that it made us think differently about how we do some of our business."

A NEXT-GENERATION COVID VACCINE

The COVID-19 vaccines from Pfizer and Moderna are highly effective, but they have shortcomings. In addition to being difficult to store and schedule, it's unknown whether they confer durable immunity to the elderly. Drexel researchers are working on a DNA vaccine and adjuvant to address those flaws.

OF THE MANY, MANY QUESTIONS raised by the novel coronavirus, two of the more common are how long do antibodies persist and why does the virus affect age groups differently?

The answers are still unclear, but professors Elias El Haddad and Michele Kutzler in the College of Medicine are trying to address those challenges through studies, trials and development of an adjuvanted DNA vaccine for human use.

As of now, the only approved DNA vaccines are for veterinary use, but many vaccines for humans are in development. They work by delivering an engineered genetic sequence into a host's cells that instructs the cells to produce an antigen that elicits the body's immune response.

In contrast with the mRNA vaccines created by Moderna and Pfizer, Kutzler and El Haddad's adjuvant DNA vaccine could extend durability, and efficacy in the elderly. Their vaccine would be capable of being stored at room temperature and, in combination with their novel adjuvant, Adenosine deaminase-1 (ADA-1), it would require only one injection. The Pfizer and Moderna vaccines require two immunizations scheduled weeks apart.

"Our vaccine is positioned in a way that if there is a second- and third-generation vaccine, we will be ready to improve on what is currently being deployed," says Professor of Medicine El Haddad.

To better understand why COVID-19 affects some people more than others, Kutzler and El Haddad are studying the immune responses of patients hospitalized with COVID-19. They're searching for a molecular structure to understand why some patients need longer care and have to be intubated and possibly die, and while others experience only mild symptoms and recover quickly. This will be used to inform on the mechanisms associated with the novel adjuvant ADA-1.

The researchers received a \$2 million grant from the National Institutes of Health (called Immunophenotyping Assessment in a COVID-19 Cohort, or IMPACC) which will contribute to a national collection of data. They recruited about 100 patients at Tower Health's Reading Hospital and Chestnut Hill Hospital and began observing their health while hospitalized and then for up to one year afterward, with a special focus on patients' immune reaction and how it correlates with the early course of their infection.

"This is a very impactful project because... one of the challenges ahead will be to determine whether the antibodies [produced by the first approved COVID-19 vaccines] are durable," says Associate Professor of Medicine Kutzler.

A DNA vaccine with adjuvant could be especially helpful for elderly populations. Age negatively influences the immune response and this has major implications for the ability of individuals to generate long-term antibodies in response to vaccines.

"We know that people 65 and older are getting the worst of the COVID-19 infection in terms of severity and in terms of death, and while there's some anecdotal data, there's no real evidence whether the elderly respond positively to the vaccine and how durable their response will be," says El

Haddad. "We also know that the vaccines that are currently available did limited studies in the elderly. Thus researchers think there's a big gap that needs to be addressed."

Primary data suggests that their vaccine combined with the ADA-1 adjuvant can boost immune responses in preclinical aging models.

"That NIH IMPACC study is important for vaccines because Dr. El Haddad and his team are going to look at underlying immune correlates of protection: Why some people recover, and some don't. It's important to understand the protective host immune response, because then we can make better vaccines that target those immune responses," Kutzler says.

Their project is both a testament to Drexel's swift response to opportunity and a reflection of the University's interdisciplinary expertise. The pair teamed up with two other Drexel projects that also received Rapid Response Research and Development funding. Irwin Chaiken, a professor in the Department of Biochemistry & Molecular Biology in the College of Medicine, is evaluating how strongly the antibodies produced by their vaccine bind to the coronavirus. College of Medicine associate professors Sonia Navas-Martin and Julio Martin-Garcia are testing whether the antibodies can prevent the virus from infecting lung tissue, using an organoid chip that replicates a human lung outside of the body.

In December, Kutzler and El Haddad were part of a group that applied for another grant, which is still pending, to extend their study to 300 individuals, in collaboration with Tower Health and St. Christopher's Hospital for Children, which Drexel co-owns with Tower Health, and with Drexel's College of Medicine and Dornsife School of Public Health. Part of their grant from the Commonwealth of Pennsylvania

is to establish a STEM pipeline with Cheyney University of Pennsylvania, an historically Black university. They'll be building a pathway for underrepresented minority students to enter the biomedical sciences, as well as opportunities for underrepresented minority faculty. (In addition, throughout the pandemic, their lab served as a training ground for medical and graduate students when most of the University was shut down.)

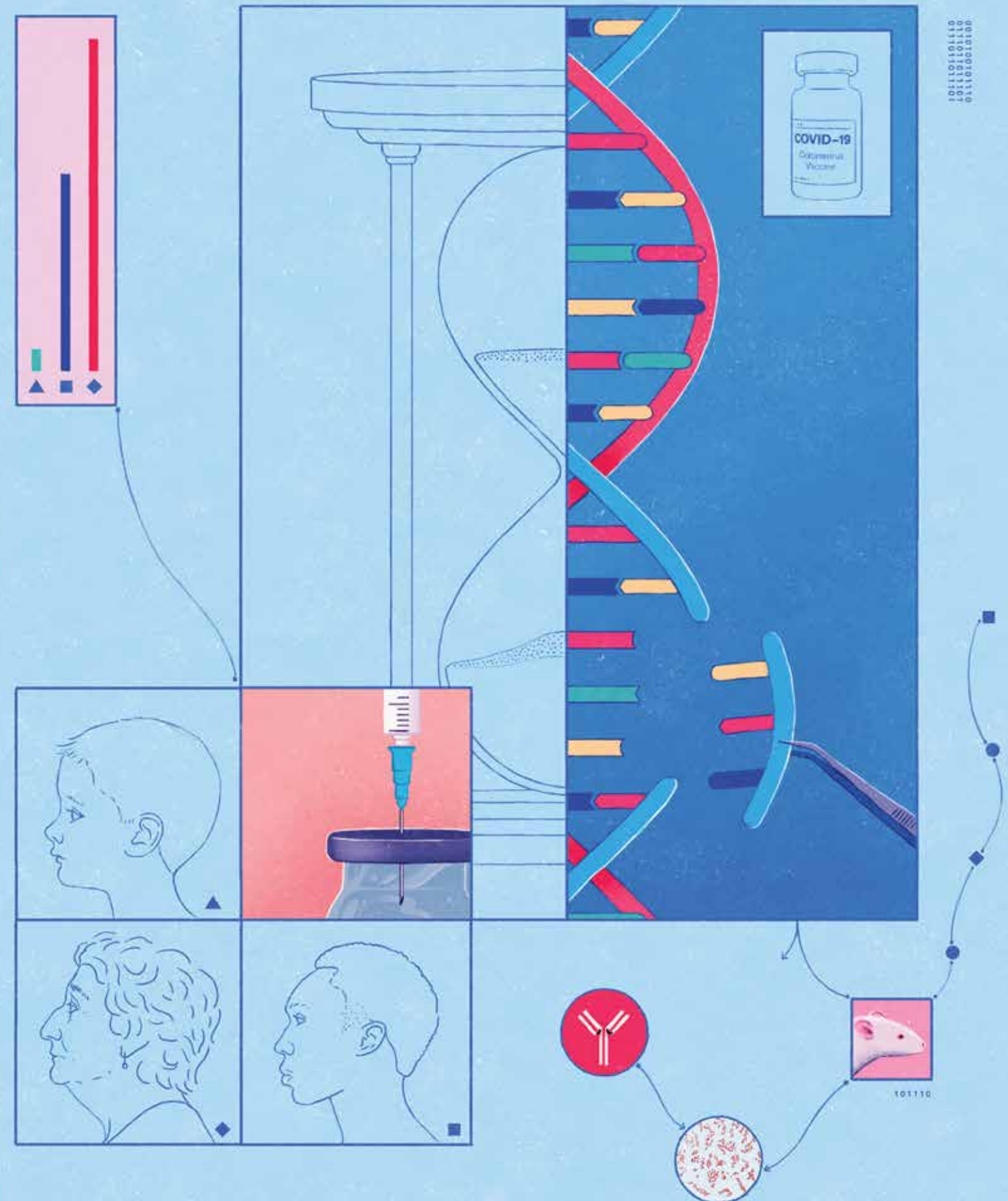
All of these developments began with a modest seed grant of \$10,000 from Drexel's Rapid Response Research & Development Fund. The grant enabled El Haddad and Kutzler to generate preliminary data that

tested ADA-1 as an adjuvant for a COVID DNA vaccine in preclinical aging models that they used to secure more collaborations and grants, including the largest grant awarded (\$1 million) from the Department of Community and Economic Development (DCEd) of the Commonwealth of Pennsylvania.

For Kutzler and El Haddad, working together for so long on a variety of projects is nothing new. For years, they've conducted research to develop vaccines and study immune responses to infections for diseases like HIV and *Clostridium difficile*.

"What's really unique about our work is that we can pivot our research pretty quickly to meet the needs of new emerging infectious diseases," says Kutzler.

"It's important to understand the protective host immune response, because then we can make better vaccines that target those immune responses."



THE ABCDs OF PPE

Drexel engineers designed an acrylic chamber to keep medical professionals safe from contagious aerosols while COVID-19 patients are undergoing intubation.

We now know what was at first only suspected: that the SARS-CoV-2 virus is spread primarily through aerosols dispersed into the air through breathing and talking.

But even before the aerosol theory was widely accepted, an ears-nose-and-throat specialist at the Hospital of the University of Pennsylvania had concerns. As more patients were being intubated and placed on ventilators, Michael A. Kohanski, a hospital otorhinolaryngologist and assistant professor at the University of Pennsylvania, asked Drexel's College of Engineering Dean Sharon Walker to engineer a device to protect frontline medical workers while they are inserting a tube into a patient's airway to help the patient breathe.

Immediately, Walker began brainstorming with faculty in her college and colleagues across the country.

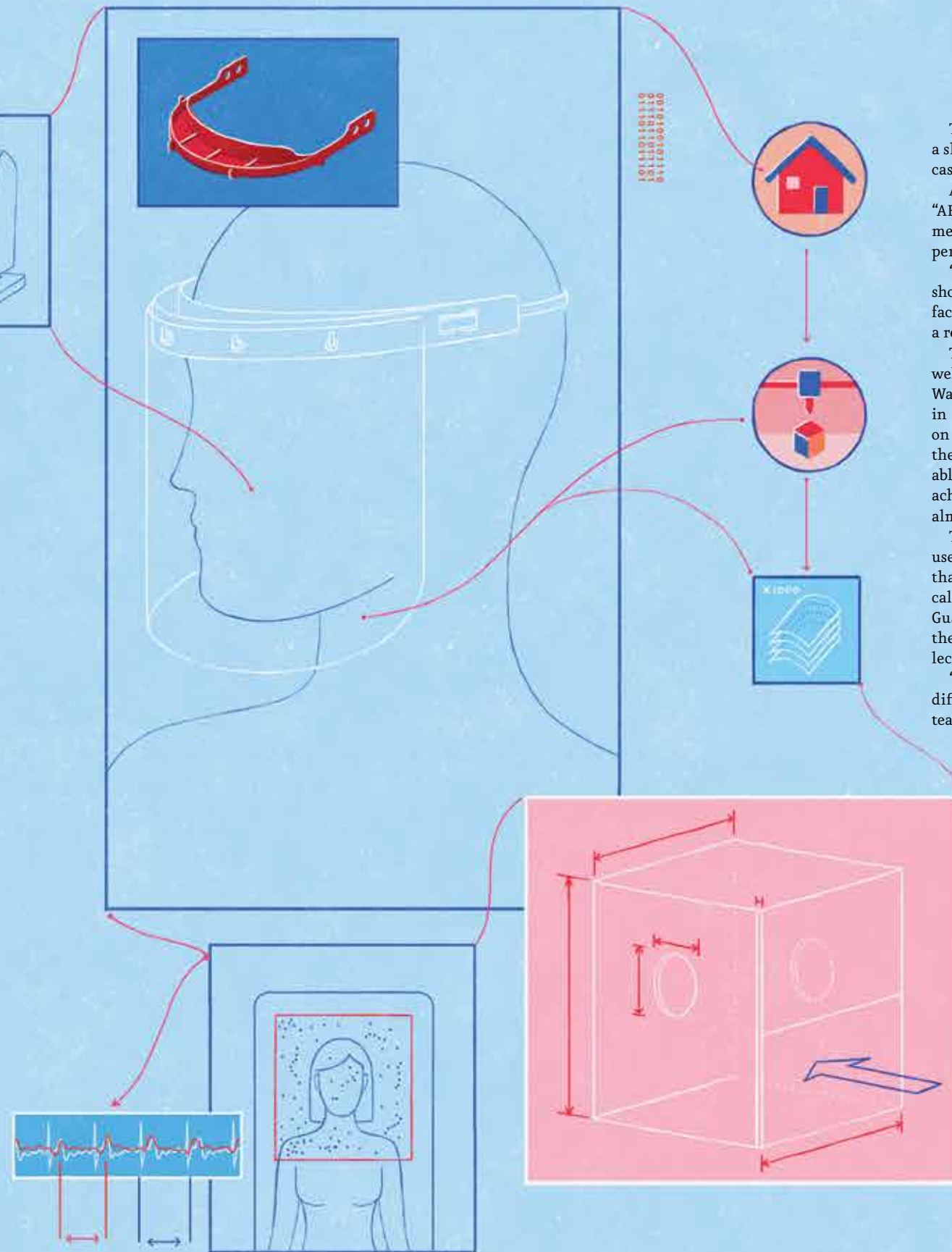
Ultimately, Drexel experts from the School of Biomedical Engineering, Science and Health Systems and the College of Engineering created prototypes that were tested and fine-tuned in collaboration with Kohanski and his colleagues in the University of Pennsylvania Health System.

The team started with a device that resembled a soft, foldable tent inspired by the rain cover of a baby carriage, placed around a patient's head. When the medical professionals asked for something more durable and easier to clean, the engineers moved on to a hard-shelled device with plexiglass and a stronger frame.

There needed to be openings for doctors to reach in for intubation, and to insert different tubing and vacuum pumps to suction out the aerosols...but there couldn't be too much airflow, and the pumps had to fit into the hospital room's existing infrastructure and work with available equipment.

It couldn't be too confining, because that may upset a patient waking from anesthesia or render the patient inaccessible to the doctor in the event of an emergency. Plus, it needed to be transparent.

"It was a fascinating time to work together and have these 'team science' and 'team design' meetings, and there's been such a flurry of activity," recalls Walker. "These physicians were in the trenches, treating patients during a pandemic, and we were still able to meet with all different types of specialists from different parts of Penn Medicine as our ideas were refined and the prototypes evolved."



The final design evolved from a contraption devised from a shower curtain liner someone had at home, to a plexiglass casing produced by an external manufacturing company.

A name was chosen: Aerosol Biocontainment Device, or "ABCD" for short. It's considered personal protective equipment (PPE) because it ultimately protects the medical personnel more than the patient.

"It's basically a big plexiglass box that fits over a patient's shoulders with disposable plastic sheeting that goes from the face down, which can be taped down and quickly removed in a real emergency," Walker says.

The prototypes were tested both in the hospital setting as well as in the lab of College of Engineering professor Michael Waring. He and Assistant Professor L. James Lo, both experts in aerosols, airflow and air ventilation, tested the device on mannequins in special sealed chambers. They measured the aerosols in fluctuating flow rates, pumps and other variables in different operating scenarios, and found the device achieved a 95+ percent reduction in aerosols that approached almost 100 percent as a function of pumping speed.

There are endless opportunities for the ABCD device to be used in different applications: in clinical settings, rather than just surgeries; dental procedures, in addition to medical ones; and in domestic military use such as National Guard activations. And with endless opportunities come the possibility of licensing the device, protecting the intellectual property and publishing papers.

"There are lots of possibilities of modifying the device for different uses," says Walker. "I imagine this is a research team that will work for years together."

"There was fear of a PPE shortage and knowing we had the excellent eye and face protection with the Drexel shields made us all feel safer."

FACE SHIELDS FOR THE FRONTLINES

In response to a global shortage of protective gear, an interdisciplinary team built and donated tens of thousands of Drexel-designed, reusable face shields to frontline workers.

AN URGENT CALL went out from Einstein Healthcare Network, Penn Medicine and St. Christopher's Hospital for Children in spring 2020. The pandemic had arrived, a surge of hospitalizations was imminent, and there was a critical shortage of face shields in Philadelphia and worldwide.

The Philadelphia-area hospitals contacted Professor Michelle Marcolongo, who was at that time the head of the Department of Materials Science and Engineering in Drexel's College of Engineering, asking for immediate assistance.

Within days, Marcolongo teamed up with School of Biomedical Engineering, Science and Health Systems Associate Professor Amy Throckmorton, College of Computing & Informatics Professor Ellen Bass and recent Drexel biomedical engineering graduate Bryan Ferrick to create a cross-campus collaborative effort to build and donate thousands of face shields.

They mobilized a network of citizen partners using 3D printers at home and high-volume injection molding manufacturers, and everything in between. Faculty, professional staff and students from half a dozen of Drexel's academic units worked with Drexel's Office of Research & Innovation and the Drexel Machine Shop to build face shields, dubbed "Drexel AJFlex Face Shields," in the University's Innovation Studio.

The team delivered their first batch of 90 face shields to Einstein Healthcare Network, Penn Medicine and St. Christopher's Hospital for Children on April 3, 2020.

"At the very beginning of the pandemic, when we were all terrified, [they] provided protection for us," recalls St. Christopher's Associate Medical Director, Population Health and Value Danielle Casher, who is also an associate professor of pediatrics at the College of Medicine. "There was fear of a PPE shortage and knowing we had the excellent eye and face protection with the Drexel shields made us all feel safer."

By the end of 2020, the team had built over 32,000 reusable Drexel face shields and donated over 30,000 to more than 100 hospitals, government and local agencies, nursing and rehabilitation facilities, and nonprofits all over the country. Additionally, when rising infections threatened India in early 2021,

the team began shipping thousands of face shields to support hospitals there.

"We can overcome any challenge when we come together as a community," says Throckmorton. "It is an honor and a privilege to contribute."

ONLINE
Join the effort to provide PPE to frontline workers by volunteering or donating: faceshields.cci.drexel.edu.

WHO TO CALL FOR #COVIDCALLS

A series of daily recordings created in the early days of the pandemic by a Drexel historian will endure as a real-time oral history of the disaster.

Scott Knowles' first thought when the pandemic arrived was to do what he always does as a disaster historian: call up experts to find out more. After all, it's what he did after 9/11 and Hurricane Katrina as the head of Drexel's Department of History.

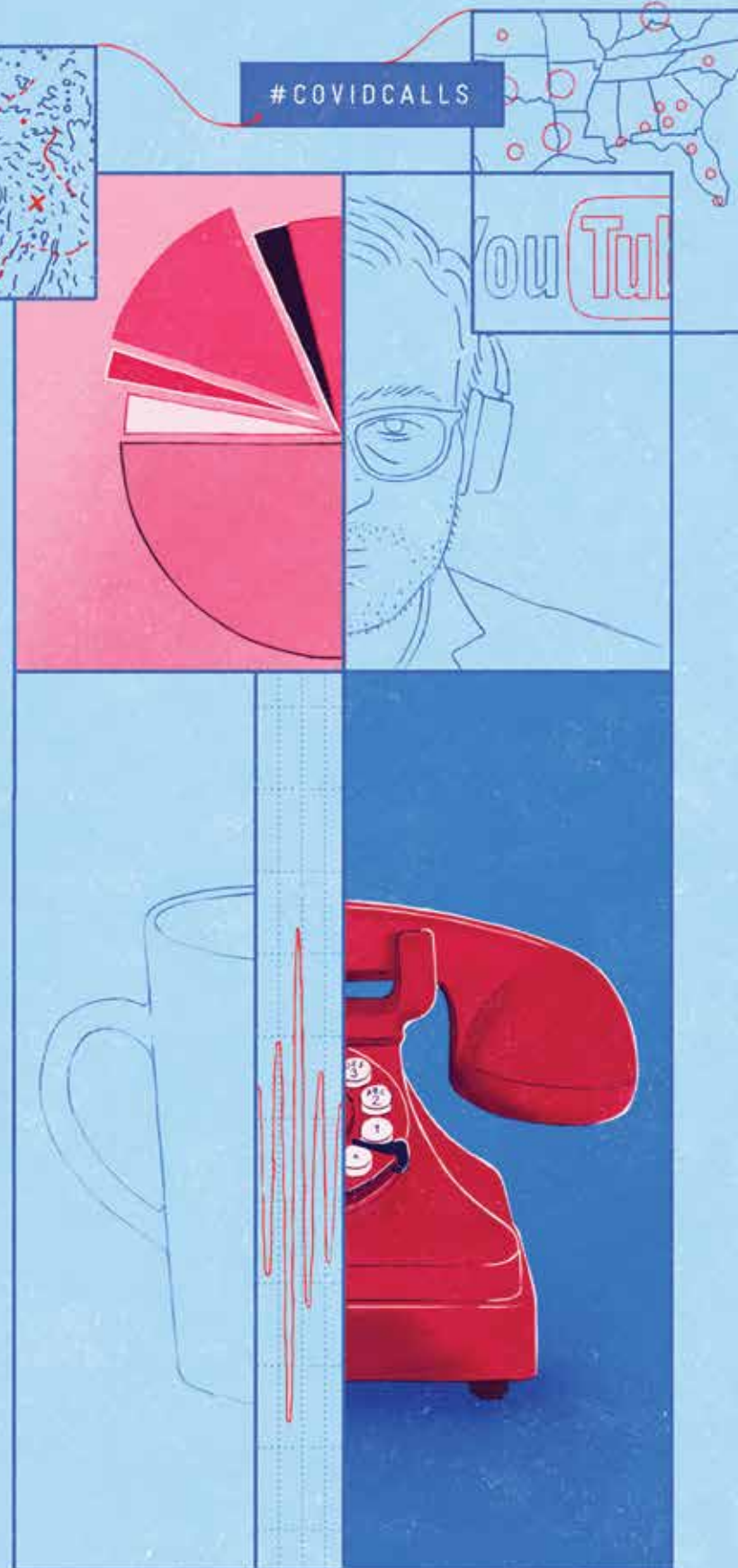
His second thought, though, was to do something completely new: broadcast his calls to the public and archive them for posterity.

On March 16, Knowles began hosting live discussions, referred to as #COVIDCalls, every weekday at 5 p.m. with historians, journalists, scholars, researchers and other experts and professionals who could shed some light on the pandemic. Topics ranged from emergency preparedness, virus testing, grief, crime rates, rural health, past pandemics and disaster response, just to name a few.

Knowles, who left Drexel in January 2021 to join the faculty of Korea Advanced Institute of Science and Technology in South Korea, wanted to paint a picture of what was happening not only in America, but around the world, where other experts were watching the crisis unfold in their home countries.

"Part of my research is about communication in disaster, so I'm literally doing that work in real time," said Knowles at the time. Knowles is the author of the 2011 book, "The Disaster Experts: Mastering Risk in Modern America."

Along the way, this has been a once-in-a-lifetime chance to promote his field. "We do not have great capacity in the United States for multi-disciplinary disaster research, but I want to show that there is a community that can come together, and when their voices get together, it's pretty powerful," says Knowles. "I'd like to see something like a Union of Concerned Scientists, but for disaster. Can I do that with a daily one-hour webinar? No. But can we use this as an opportunity to build a stronger community of researchers? Absolutely!"



A UNIQUE SENSOR FOR DETECTING CORONAVIRUS

A novel way of testing for the coronavirus involves a piezoelectric sensor that has already been successfully deployed to detect breast tumors.



HEALTH CHECKS ON YOUR PHONE

An app built by Drexel has become the go-to method for Dragons to track symptoms and schedule and receive results from on-campus COVID-19 testing.



A HUSBAND-AND-WIFE TEAM at Drexel believes that a piezoelectric sensor they developed in their lab can be used to detect SARS-CoV-2 infection.

Professor Wan Y. Shih in the School of Biomedical Engineering, Science and Health Systems and Professor Wei-Heng Shih in the College of Engineering are co-inventors of a piezoelectric sensor that is already being used successfully worldwide to detect breast tumors. Piezoelectric refers to the ability of certain materials to generate an electrical charge when pressure is applied. The technology has already proven itself commercially under the label iBreastExam.

For their newest application of piezoelectric detection, they have coated a very thin piezoelectric sensor with probe RNA complementary to the RNA of the coronavirus. They expect that when the viral RNA binds to the probe RNA, the resonance frequency of the sensor will shift, indicating a positive infection.

Their diagnostic promises to be portable, inexpensive and easy to use, says Wan Shih. "The test takes only 30 minutes from nasal swabs or saliva samples," she says. "It is ideal to be made widely available at point of care." — Sonja Sherwood

The idea of using phone apps to track COVID-19 infections may make Americans uneasy, but there's no question that tracking technology helped quell early initial outbreaks in China, Singapore and South Korea.

Here in the United States, Apple and Google developed an operating system-based cell phone beacon to automatically identify and log exposures to nearby cell phone users for instantaneous and anonymous contact tracing. But before that had been released to the public, the Drexel Health Checker App was already up and running, available in Apple's App Store. The app has been an essential player in the University's COVID-19 response since April 2020.

The app, designed to raise situational awareness of COVID-19, was developed by a team of collaborators led by Walter H. and Leonore Annenberg Dean of the College of Medicine and Senior Vice President of Medical Affairs Charles B. Cairns.

The Drexel Health Tracker allows University faculty, staff and students to monitor their symptoms and receive urgent health alerts from the city and the University. Dragons use the app to follow how the SARS-CoV-2 virus is being transmitted over time and across locations.

When students returned to campus in winter 2021, the app was augmented with a HIPAA-protected medical portal to deliver test results to those who used it to schedule a test on campus — just like you would get from your doctor when you go on a portal. A Web-based version of the app was also created for visitors to campus to log their symptoms. When vaccines became available, the app became a way to confirm vaccination, too.

What's next? The developers see the app eventually being adopted and customized by other academic and medical institutions.

THE REST OF THE BEST

More Drexel projects that received the University's Rapid Response and Research and Development funding....

The College of Nursing and Health Professions' **Rose Ann DiMaria-Ghalili, Kimberlee Montgomery** and **Gloria Gonzalez-Kruger** and the College of Medicine's **Michael Weingarten** examined how providers and older adults perceived the pandemic's toll on physical and mental health as well as telehealth care delivery.

The College of Medicine's **David Bennett** and **Barbara Schindler** and College of Computing & Informatics' **Christopher C. Yang** and **Ou (Stella) Liang** developed an online peer support community for women in treatment for substance use disorders who may feel vulnerable and isolated during COVID-19 sheltering.

The Dornsife School of Public Health's **Neal Goldstein** and **Igor Burstyn** advanced methods for more accurately quantifying COVID-19 cases in Philadelphia when relying upon surveillance data collected by the health department.

The Dornsife School of Public Health's **Jennifer Taylor** and **Andrea Davis** of the LeBow College of Business' **Christian Resick** looked at how the pandemic affected first responders in fire departments, with preliminary findings showing increased burnout, anxiety and depression, and decreased job satisfaction and work engagement.

The Dornsife School of Public Health's **Allison Groves** looked at the disproportionate impacts of COVID-19 on low-income and minority communities.

The Dornsife School of Public Health's **Amy Carroll-Scott** and **Félice Lê-Scherban** created an interactive online dashboard to track which areas of Philadelphia would be the most vulnerable to health, social and economic impacts of the pandemic or most likely to turn into COVID-19 hotspots, using maps and data for pre-COVID social, economic and health conditions.



The College of Medicine's **Simon Cocklin** and **Adel Rashad** discovered a hit compound, or molecule that confirms activity in screening during early drug discovery, that inhibits the SARS-CoV-2 virus' entry into a host cell — the first step in infection. They aim to develop an antiviral drug to supplement vaccine efforts as a pre-exposure prophylactic to reduce transmission and treat those already infected.

S P O T T I N G

INVISIBLE

INJURIES

A medical device startup housed within Drexel's School of Biomedical Engineering has spent years perfecting a brain injury scanner that is saving lives around the world as it travels a long but rewarding road toward commercial success.

_by Christina Hernandez Sherwood



_HOW IT WORKS

The Infrascanner contains a near-infrared spectroscopy sensor that, when placed in four areas of the scalp, compares the left and right sides of the brain. It records the absorbance of light at selected wavelengths to pinpoint bleeding on the brain.



IN 2008, AN AMERICAN military contractor working in the Iraqi city of Fallujah came to a trauma unit operated by U.S. Marines complaining of headaches. A few days earlier, the vehicle the contractor was traveling in had hit a bump, knocking his head against the roof. He was seen by Luis Becerra, MD, a neurologist and U.S. Naval Officer with the U.S. Marines deployed during the Iraq War troop surge. The patient appeared normal during his exam and had no other outward symptoms, but Becerra decided to observe him for 24 hours, during which time the man's condition declined. Becerra believed he was suffering from a potentially lethal brain bleed.

In prior deployments, the doctor would have had to rely solely on his observation of clinical symptoms, such as slurred speech and disorientation, to determine if a patient should be transported to one of the two medical centers in Iraq equipped with a computed tomography (CT or CAT) scan machine that could confirm a head injury. The stakes are high: An expensive helicopter evacuation for a patient who turns out healthy is a waste of precious resources; conversely, waiting too long to treat a head injury could be fatal. On that particular day, a dangerous sandstorm raging across the region also weighed on his decision.

This time, however, Becerra had a new tool in his kit: the Infrascanner 1000, a handheld device developed by a Drexel spin-off that can detect a brain bleed within minutes. After a few passes across the contractor's scalp, the test returned a positive result, confirming the doctor's diagnosis and telling him the approximate size and location of intracranial bleeding.

The contractor was quickly air-lifted by helicopter to a hospital in Balad, 50 flight miles to the north, where a CT scan confirmed a bilateral subdural hematoma.

The Infrascanner's test result probably saved the man's life, Becerra recalls. "The [evacuation] had to be approved by the three-star general," he says. "You have to make a really strong case that something needed to be done immediately."

EARLY DAYS

Back in Philadelphia, the team at Infrascan, the University-based startup that makes the Infrascanner, would draw on this and other early successes to buoy them through a turbulent decade — through a years-long FDA approval process that stalled sales, through the resulting budget crisis that suspended the company's operations, and through political battles in Washington, D.C., that wreaked collateral damage on its military contracts. All the while, the future of a life-saving new technology hung in the balance.

"In startups, when you have challenge after challenge that you need to overcome, sometimes you think, am I persistent or am I just plain stupid?" says Baruch Ben Dor, founder and CEO of Infrascan. "[But] when you feel that you're really making an impact, and really helping people, that makes it all worth it."

As of this year, the company has sold more than 1,000 Infrascanners globally, from Middle East war zones to as far away as the Andes Mountains of South America. With a strong foothold in military and international sales, Infrascan is now planning its expansion into the United States medical market, eyeing ambulances, pediatric emergency rooms and other health care settings where speed, portability and cost matter. In the meantime, Drexel biomedical engineers are constantly improving the Infrascanner, which has evolved from a two-part system to a single device roughly the size of an iPhone, and adding new functions to detect more injuries.

"There is no end to this; there's so much that can be done eventually," says Banu Onaral, H. H. Sun Professor of Biomedical and Electrical Engineering at Drexel and chair of the Infrascan board. "We're introducing not only a breakthrough technology, but also creating a new neurotechnology niche where handheld [devices] will save your brain."

The technology behind the Infrascanner was originally intended not to save your brain, but to boost your muscles. The idea came from Britton Chance, who won an Olympic gold medal in sailing in the 1950s before joining the University of Pennsylvania as a bio-physicist. Chance, who died in 2010, was one of the first medical scientists to experiment with near-infrared light, which is light that, while invisible to the eye, can penetrate the skull. Chance developed a technology that used different wavelengths of near-infrared light to detect oxygen capacity in muscles. Then, in 1997, Chance and Claudia Robertson, MD, a neurosurgeon at Baylor College of Medicine, completed a study that determined that the technology was also effective in detecting intracranial hematoma, or blood in the skull.

“And, typical to academia, that’s where it stopped,” says Infrascan founder Ben Dor.

At least, that’s where it would have stopped, had Ben Dor been willing to let it go.

Ben Dor is a physicist who had been managing a medical device startup in Israel before he joined Chance’s laboratory in 2002 as a postdoctoral researcher. Whether because of his background in industry or his eight years in Israeli military service, Ben Dor believed that the technology had merit beyond academia. With Chance’s blessing — and the help of some business students — he entered, and won, the University of Pennsylvania’s 2004 Wharton Business Plan Competition, which came with a \$20,000 prize. Then, to really get the idea off the ground, he needed a team.

Just blocks away on Drexel’s University City campus, Banu Onaral was growing Drexel’s new, interdisciplinary School of Biomedical Engineering, Science and Health Systems, which she helped to establish with a commitment to translate cutting-edge academic research into life-saving technology solutions. She was initially hesitant of Ben Dor’s suggestion of a partnership — as an academic she stayed away from for-profit projects — but her belief in translational research won out.

“This intrigued me,” she says. “I always felt terrible that we had such beautiful solutions as laboratory prototypes sitting on our shelves and never moving forward.”

Ben Dor launched Infrascan in 2005, with his team handling the business side and Drexel serving as its scientific backbone.

The partnership has worked so well — and lasted so long — because it benefits the missions of both Infrascan and Drexel, says Kurtulus Izzetoglu, an associate professor of electrical and biomedical engineering at Drexel and an Infrascan co-founder. Infrascan co-exists with the school’s educational mission as a living case study for biomedical students to see firsthand how to move academic ideas and technology into commercial use. Startups need institutional backing to get grants to fund their work, he says, while universities need startups to push their translational research into the world.

“We created this model to show how academia and industry can work effectively and efficiently,” Izzetoglu says. “We help their survival because they are a startup. They help us on translational research, so our students can learn more about how technology can be developed and moved to the patient side.”

“We created this model to show how academia and industry can work effectively and efficiently. We help their survival because they are a startup. They help us on translational research, so our students can learn more about how technology can be developed and moved to the patient side.”

-KURTULUS IZZETOGLU
associate professor of electrical and biomedical engineering at Drexel and an Infrascan co-founder

Ben Dor, whose stint as an Israeli Air Force scientist in the late 1980s and early '90s leading research and development projects gave him an inside perspective on the military, approached the U.S. military with his technology. In 2005, Infrascan received funding from the Office of Naval Research to spend several years developing its first product, a two-part system including a mobile device and a handheld scanner, called the Infrascanner 1000. Eventually Infrascan would go on to accumulate \$10 million in grants from the U.S. Department of Defense over 15 years. Several Philadelphia-area economic development agencies, including BioAdvance, Ben Franklin Technology Partners of Southeastern Pennsylvania and Philadelphia Industrial Development Corp., also provided early funding.

In Iraq, Becerra used the Infrascanner to evaluate some 140 head trauma patients, placing the scanner on eight locations on the head for five to 10 seconds each. When the scan was complete, the mobile device displayed a crude picture of the head with normal regions represented in green and bleeding indicated in red. Even if some measurements needed to be repeated, Becerra knew within five minutes whether a patient had internal bleeding.

During Becerra’s seven-month deployment, three people, including the American contractor who was evacuated during a sandstorm, a U.S. soldier and an Iraqi policeman, received positive Infrascanner results and were sent to medical centers for treatment. “If you are in a place that is remote, it’s always better to have as many tools as possible,” Becerra says. “This is our tool.”

Today, the U.S. military is Infrascan’s biggest single customer. But expanding sales in the United States has proved to be a trickier endeavor for Infrascan. The company expected its device to be approved by the U.S. Food and Drug Administration within three months. Instead, the process took nearly five years.

The delay meant the Infrascanner couldn’t be sold in the United States, nor in the many countries worldwide that won’t sell American medical products without FDA clearance. Potential investments dried up, Infrascan suspended operations and, for several months in 2009, the team went without pay.

“I think we were down to: Plans A, B, C, D and E doesn’t work,” Ben Dor says. “[But] we had a couple of things on the horizon that would help us.”

Drexel offered the team adjunct faculty positions, a timely grant came through and the device was approved for sale in Europe.

By the time the Infrascanner 1000 finally received FDA clearance in 2011, the company had already developed its next model. Funded by the U.S. Marines, the Infrascanner 2000 merged its predecessor’s two components into a single, more rugged device.

Yet the challenges for Infrascan continued. As the FDA approved the new device in 2013, the U.S. budget sequestration that year cut the company’s contract with the Marines in half.

Even so, the Infrascan team was boosted by another success story. During an evaluation of the Infrascanner 2000 by U.S. Marines, the device helped save the life of an Afghan boy. The boy’s only clinical symptom was a small cut to the head, but the Infrascanner indicated a brain bleed. The child was evacuated to a hospital for life-saving surgery. “That’s where you feel that...making [the technology] commercial and making it actually reach patients makes the real big difference,” Ben Dor says. “It’s not just a technology. It has a real impact.”

The Infrascanner was deployed to Afghanistan for military use, but its impact on the Afghan boy highlights another avenue the company was pursuing: the potential for the device to make in-roads in poor and rural regions worldwide, where its portability and dramatically lower cost over CT equipment give it an advantage. Some developing countries have fewer CT scan machines than a single U.S. medical center, Ben Dor notes, and that lack of access to head trauma diagnosis and treatment means more disability and death.

Andres Rubiano, MD, a neurosurgeon in Colombia specializing in trauma, believes the Infrascanner could serve as a powerful health care tool in areas with few medical resources. Rubiano, who this summer expects to publish the results of his study on the accuracy of the Infrascanner on 150 patients in Colombia, is now using the device to determine whether head trauma patients in rural Guatemala need surgery.

“There are going to be settings where the device will make a lot of difference: low-resource settings, maybe military settings, also some sport-related injury areas,” says Rubiano.

MARKET DREAMS

The Infrascan team has no illusions about its chances of replacing CT scans as the gold standard of care for brain injuries in the United States, where some 70 million CT scans are performed each year.

Instead, the company frames its device as a way to prevent unnecessary radiation exposure in the United States. A typical head CT scan exposes a patient to about two millisieverts of radiation, which, while on the lower end of radiation doses from CT scans, can still elevate lifetime cancer risk. The radiation produced by the Infrascanner, by contrast, is comparable to that of a TV remote control.

Radiation exposure is especially worrying for children. One study found that patients who had two to three CT scans in childhood tripled their lifetime risk of developing brain tumors. Many countries worldwide already use the Infrascanner in pediatric settings, Ben Dor says, and the company is preparing a submission to the FDA for clearance for pediatric use in the United States, as well.

Infrascan has begun studies at several U.S. hospitals. One research project is expected to expand to a multi-center study at 10 of the top trauma research centers in the world. This will focus on the Infrascanner technology in monitoring neurointensive care and emergency department patients. These patients, Ben Dor says, would otherwise be exposed to repeated CT scans as doctors decide if, and when, their condition worsens enough to require surgery. The Infrascanner could also serve patients under the influence of drugs or alcohol, he says, who are frequent candidates for head CT scans because their symptoms mimic those of head traumas.

Once proven in hospitals, the company wants to see the Infrascanner deployed in ambulances. The device is simple to operate with just two hours of training. Ben Dor says that the device would let emergency workers immediately assess whether a head injury patient could be treated at a local hospital or must be transferred to a trauma center.

“THIS IS FUTURISTIC STUFF, SCIENCE-FICTION-TYPE STUFF, BUT IT’S FEASIBLE AND FULL OF PROMISE FOR BRAIN HEALTH AND PERFORMANCE.”

-BANU ONARAL
H. H. Sun Professor of Biomedical Engineering and Electrical Engineering at Drexel University

The long, and often bumpy, road for Infrascan highlights the challenge of introducing the established health care community to an entirely new type of medical device, says Hasan Ayaz, an associate professor of electrical and biomedical engineering and an Infrascan co-founder. “It’s not only developing your engineering technique, but it’s also communicating to all stakeholders, understanding the process, placing it into the right spot,” he says. “When you develop a completely new, novel technology... that’s another kind of soul searching, another aspect of the translation.”

As Ben Dor and the Infrascan team explore niches for their technology, Drexel engineers are continuously updating the device. The latest breakthrough came in 2018, when the U.S. Army asked for a miniaturized version. The smaller, smarter and more efficient Infrascanner 2500 was approved by the FDA last year. It’s about the size of an iPhone, weighs less than half a pound and works on four AA batteries.

Also on the horizon: a multi-function Infrascanner that will use the same near-infrared technology to detect about a dozen different data points, from the dangerous (cerebral edema, or swelling of the brain) to the interesting (muscle fitness — the very thing for which Chance intended to use the technology decades ago).

Infrascanner represents just the beginning of the potential advances the Drexel team can make in how health care is delivered throughout the world, Onaral says.

“The non-fancy side,” she says, “is that we can shine this light and see if you are bleeding in the brain.” The fancy side? That’s functional near-infrared spectroscopy, she says, which involves using the same light to study cognition and watch the brain in motion as it learns. This technology uses the same blood oxygenation information the Infrascanner collects in order to study attention and brain activation. The applications, Izzetoglu adds, could range from monitoring student learning to helping NASA understand cognitive load.

The journey is a long one, Onaral says. “Other neurotechnologies we’re working on make people think that we are talking science fiction. No, come to our lab, let’s monitor your brain activity,” she invites. “This is futuristic stuff, science-fiction-type stuff, but it’s feasible and full of promise for brain health and performance.”

ARCHIVES

_NATURAL HISTORY, ILLUSTRATED

The Academy Library and Archives of the Academy of Natural Sciences of Drexel University contains rare and historically significant books with exquisitely detailed scientific illustrations documenting the natural history of life.

The Academy Library and Archives at the Academy of Natural Sciences of Drexel University is internationally recognized for its rare and historic books, journals, art, artifacts, manuscripts, photographs, and the unique papers and research of Academy members and staff.

The Library holds more than 250,000 titles that span from 1520 to present, including manuscripts by historically significant figures such as John James Audubon and Charles Darwin.



01



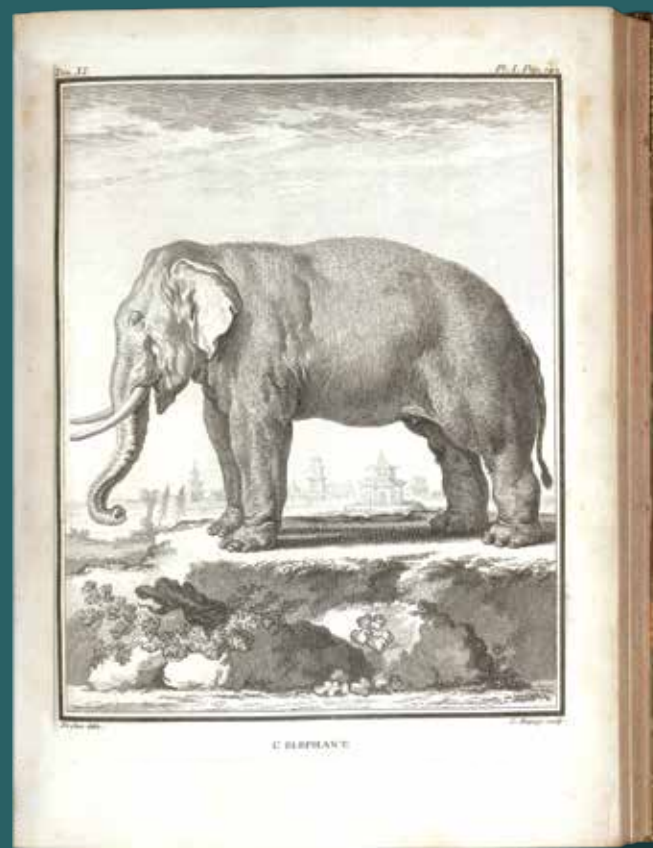
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01 VULPES VELOX, SAY. SWIFT FOX.

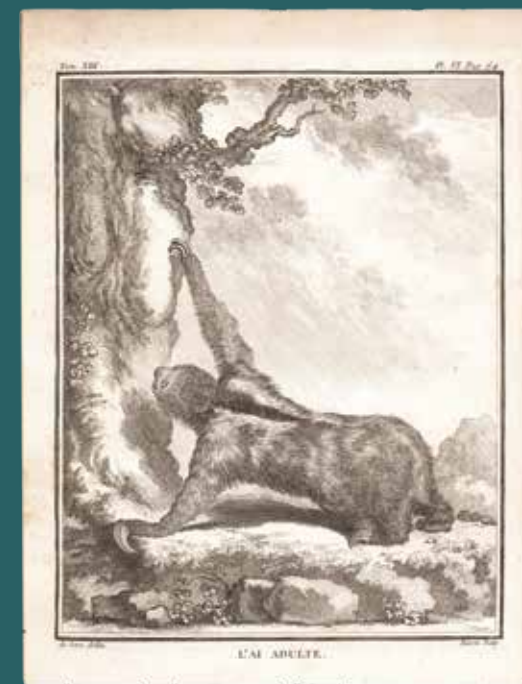
02 BOS AMERICANUS, GMEL (AMERICAN BISON OR BUFFALO)

The Viviparous Quadrupeds of North America / by John James Audubon

John James Audubon was a member of the Academy of Natural Sciences and is best known for his masterpiece "Birds of America." His book on quadrupeds was his next large-scale project, and the quality of the plates are comparable.



03



04

03 "L'ELEPHANT

04 "L'AI ADULTE (THREE-TOED GROUND SLOTH)"

Histoire Naturelle, Générale et Particulière / by Georges Louis Leclerc, Comte de Buffon

IMAGES COURTESY ACADEMY OF NATURAL SCIENCES OF DREXEL UNIVERSITY

05



07
PHALAENA REGIA
 (PERSIMMON MOTH,
 CATERPILLAR AND PUPA)*

The Naturalists' Miscellany, or
 Coloured Figures of Natural
 Objects / by **George Shaw**

Once an ordained deacon,
 George Shaw quit to pursue
 his love of natural history.
 He co-founded the Linnean
 Society and identified many
 new species from Australia
 while working at the British
 Museum.

07



06

05 "CALYPTORHYNCHUS BASKSII
 (RED-TAILED BLACK-COCKATOO)"

The Birds of Australia / by **John Gould**

06 "RHEA DARWINII"

The Zoology of the Voyage of H.M.S.
 Beagle / by **Charles Darwin, Esq.**

IMAGES COURTESY ACADEMY OF NATURAL SCIENCES OF DREXEL UNIVERSITY

08



08
 GRANAAT BOOM

10
 (following page)
 "SURINAAMSCHE
 KROCODIL (SURINAM
 CROCODILE)"

Dissertatio de Generatione et
 Metamorphosis Insectorum
 Surinamensium / by **Maria
 Sibylla Merian**

Maria Sibylla Merian's
 work depicted, possibly
 for the first time, the
 metamorphoses of insects
 and the flora and fauna
 that surrounded them.
 This was no small feat in
 the 17th century, and her
 work influenced other
 great naturalists includ-
 ing John James Audubon,
 Mark Catesby and William
 Bartram.

09

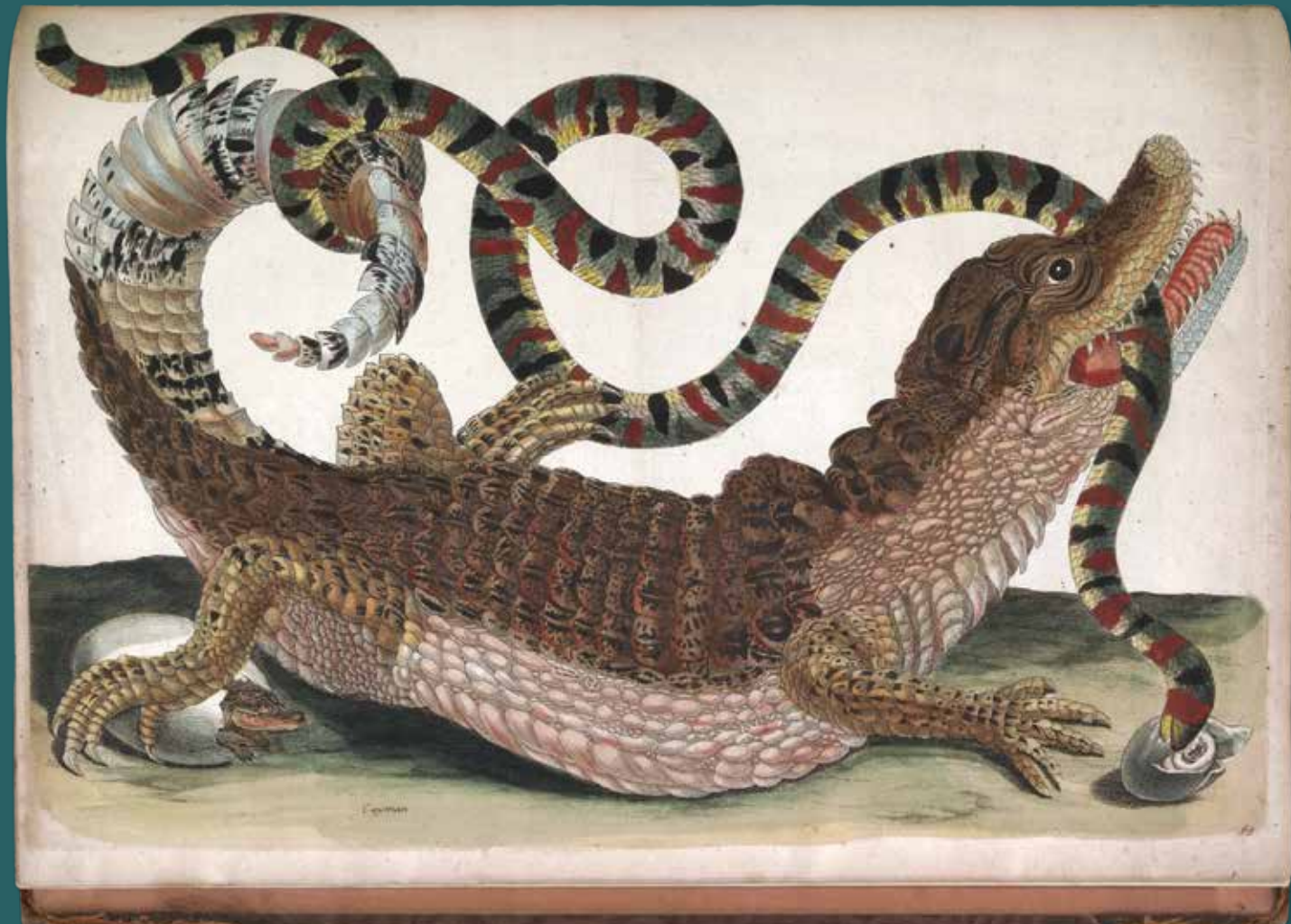


09 SCORPANA HISTRIO

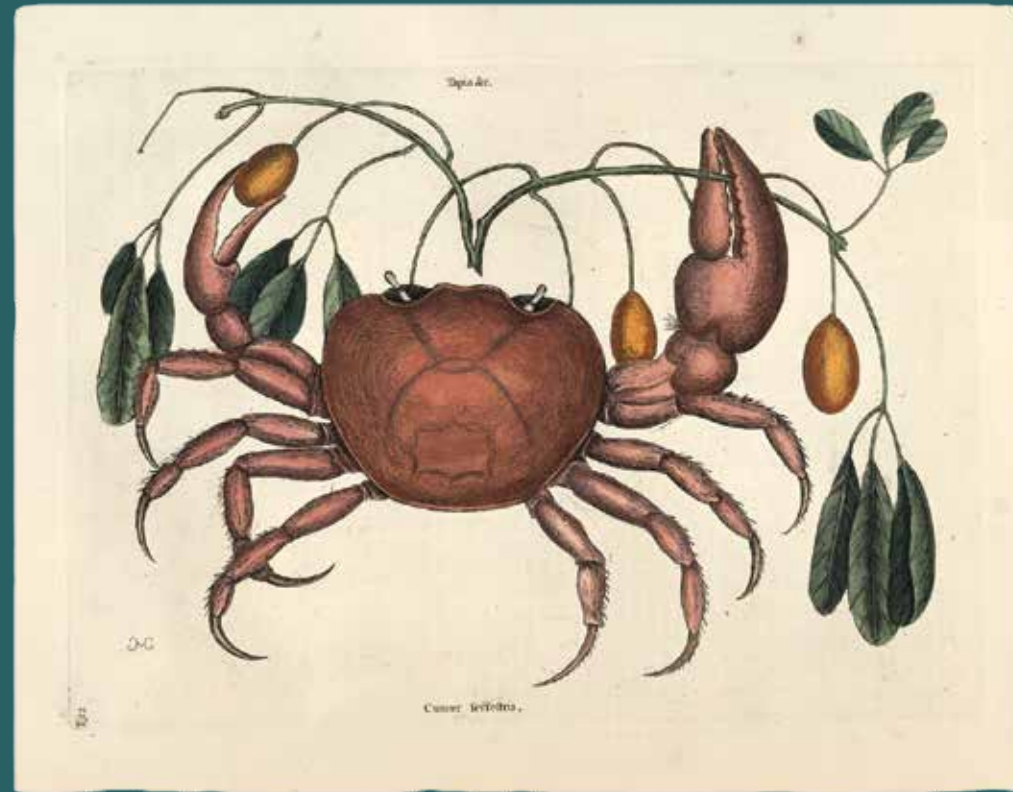
The Zoology of the Voyage of H.M.S. Beagle / by Charles Darwin, Esq.

This book details the specimens collected by Charles Darwin during the H.M.S. Beagle's voyage around the coasts of South America, Australia, Africa and elsewhere. The series was initially issued in five parts over four years. Each part was authored by an expert in the field. Darwin's observations on this trip led him to develop his theory of evolution.

10



IMAGES COURTESY ACADEMY OF NATURAL SCIENCES OF DREXEL UNIVERSITY



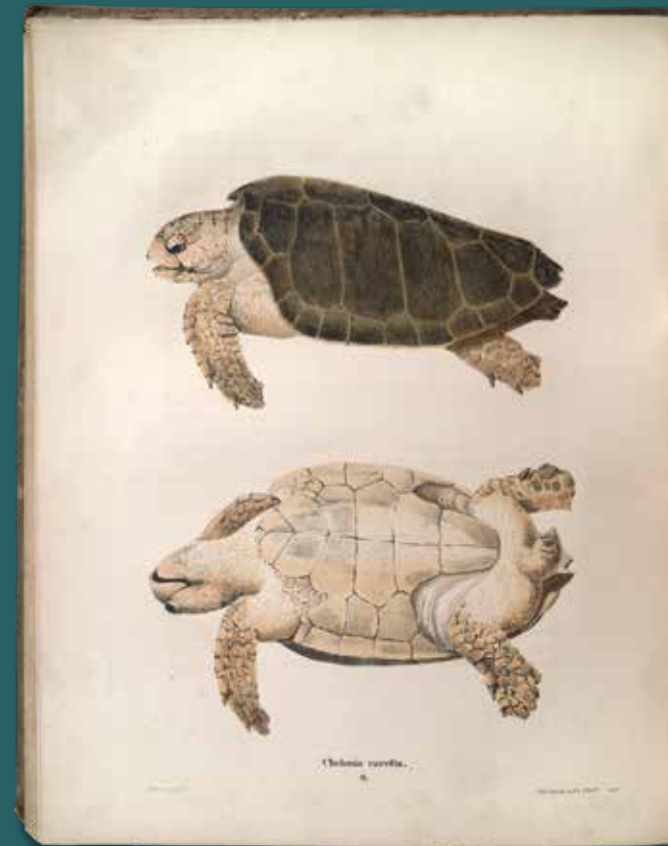
11

11 LAND CRAB

The Natural History of Carolina, Florida and the Bahama Islands / by Mark Catesby

Mark Catesby's etchings were said to be "drawn from life," unlike other naturalists and artists of his time whose work was drawn from dried specimens or described second hand.

12



12 "CHELONIA CARETTA (LOGGERHEAD SEA TURTLE)"

13 "COLUBER EXIMIUS"

North American Herpetology / by John Edwards Holbrook

13



°°° DREXEL'S
 • PLAY
 ON
 THE
 BUSINESS
 OF
 RESEARCH

*A neuroscience study on gaming with esports booster Comcast is the latest project orchestrated by the Drexel Solutions Institute as it remakes how higher education collaborates with external partners. _by Lini S. Kadaba
 _photographs by Jeff Fusco*



INSIDE THE GERRI C. LEBOW HALL at Drexel, marketing doctoral student Hongjun Ye settles in front of a computer and launches *Overwatch*, a popular online multiplayer videogame. For the next several minutes, she defends a payload by peppering enemy bots as they try to duck behind the stone pillars of a red pagoda in a futuristic world. “I like to play video games,” allows Ye, who is a fan of *Overwatch* as well as other first-person shooter games such as *Counter-Strike* and *Borderlands*. But this was much more than downtime from the demands of a doctoral degree. The gameplay inside LeBow’s Behavioral Lab was a dry run for a cutting-edge neuroscience research project involving military veterans that Comcast NBCUniversal contracted with Drexel to design, develop and conduct.

“I really like industry-based projects,” Ye says, during a break from the game. “Students cannot just conduct experiments in the lab and talk about everything in terms of pure theory. It has to connect with the real world.”

Fellow researcher Adrian Curtin agrees. “You consider the impact,” says the post-doc, who was drawn to the project by his research interest in non-invasive neuroimaging. “A lot of times, when you deal with research, you’re focused on knowledge: I want to discover how this works, because I want to know how that works... Working together with private companies gives you a different perspective, a different way to think.”

Adds Ye: “This is a perfect opportunity.”

It’s an opportunity that may never have occurred but for the existence of a unique resource within Drexel called Drexel Solutions Institute. The institute plays a matchmaker role in connecting industry partners with the University’s academic research enterprise.

Formed about five years ago as Drexel Business Solutions Institute within the LeBow College of Business, it expanded to a university-wide role in 2019 and dropped *business* from its name. Now, the three-person unit serves as a gateway for companies, nonprofits and governmental entities to partner in a fee-for-service model with Drexel faculty and top students on customized engagements that range from targeted research to co-designed curricula to tailored workforce training. Project fees typically range from \$10,000 to \$200,000 to cover the expenses of faculty members’ time and project management.

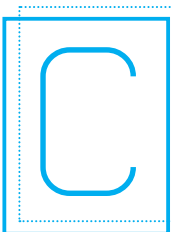
“Organizations have a one-stop shop to access Drexel’s diverse expertise,” says Anna Koulas, who, as vice president of DSI, helps to identify and cultivate partnerships. “DSI is bringing together the best of Drexel.”

So far, dozens of faculty members and about 280 students of all levels have worked with outside organizations on 18 projects coordinated by DSI. In addition to the esports study for Comcast, faculty and students have helped business partners gauge the sustainability impact of a clean water project in rural India; create a one-of-a-kind experiential program for a social services nonprofit; assess consumer responses to PECO’s dynamic utility pricing models; and market test a new hot beverage machine for coffee company Lavazza.

This way of arranging external research opportunities on behalf of the entire University — orchestrated by a dedicated, in-house unit — uniquely complements Drexel’s orientation toward practical coursework, interdisciplinary scholarship and real-world co-op experience.

“In a lot of these relationships, we’re looking to create new pathways for collaboration that have not traditionally been avenues for academic institutions to partner with industry,” Koulas says. “We forge new areas of innovation. We also show them the value of our expertise and resources.”

By all accounts, the DSI model is rare in higher education and sets Drexel apart from its peers. “A lot of universities do projects,” says Michael Howley, a clinical professor in LeBow’s marketing department who has participated in numerous DSI engagements. “But they can’t do it at the scale we do, reaching across the organization, identifying expertise, pulling students onto these projects. That’s really unique.”



COMCAST VETTED OTHER POTENTIAL partners for the esports project, but “Drexel stood head and shoulders above the rest,” says Rebecca Gray, executive director of the company’s Military & Veteran Affairs program. “We want academic research, the quality of research that Drexel is going to produce,” she says.

Comcast also liked that the hometown university — in addition to its global reputation, its emphasis on outcome-based experiments with practical social impact and its inclusion of student researchers — is a Yellow

Ribbon school with a strong commitment to veterans, like Comcast’s own. And the two have a long-standing relationship through the Drexel co-op program.

In presenting Comcast with the University’s custom research capabilities, DSI leaders proposed a research design that married Comcast’s expanding footprint in the billion-dollar esports segment to its interest in engaging with veterans, many of whom happen to be drawn to first-person shooter games that, like *Overwatch*, involve working as a team to accomplish a goal.

Comcast was well aware that gaming was popular among military veterans (in 2018, the U.S. Army announced an esports team and the U.S. Department of Veteran Affairs surveyed vets on the topic), but the company wanted more knowledge. “What we want to do is understand more of the why,” says Gray, “and can we utilize that information to impact our business decisions and our gaming efforts and esports efforts? We want data and insight to add breadth and depth into this area, and to connect with and serve the military community.”

DSI assembled a team of interdisciplinary researchers to manage the project, including Rajneesh Suri, vice dean for research and strategic partnerships and the academic lead for DSI; Lauren D’Innocenzo, an associate professor of organizational behavior at LeBow; and biomedical engineering Associate Professor Hasan Ayaz. A team of nine post-docs, graduate and undergraduate students also signed on to the effort.

As Suri and Ayaz discussed the scope of the 11-month study with Gray, they suggested assessing brain-to-brain coupling, or neuro-synchrony, between *Overwatch*-playing dyads from the 120 participants made up of half vets and half civilians.

The key questions: Are team players — whether two vets or two civilians with different experience levels — in sync; that is, literally on the same wavelength through neural synchrony — as they escort the payload to its destination? And if so, what specific aspect of

their communication leads to this bonding? The study also considers the difficulty level of the game and how the players’ proximity to each other, looking at both remote and in-person play, impact teamwork.

“Neurophysiological measures of the brain provide us with a unique new perspective on mental processes, and complement and expand up behavioral performance metrics,” Ayaz says. The researchers even got the gaming company that produces *Overwatch* to customize the game for their experiment by creating special tasks for the players that emphasize teamwork.

As Ayaz explains, he is most excited about using wearable brain and body sensors to assess team dynamics and simultaneously monitor multiple brains cooperating on the same game scenarios. The project combines both fNIRS and EDA to non-invasively gauge players’ mental efforts. fNIRS, or functional near-infrared spectroscopy, and wearable neuroimaging more broadly, is Ayaz’s bailiwick. While earning his graduate degrees at Drexel, he developed new neuroimaging methodologies and a novel brain-computer interface, and today his lab is a leader in investigating how the brain functions in workplace and everyday settings, which is part of a new field known as neuroergonomics. (Ayaz is one of the field chief editors for a new international journal called *Frontiers in Neuroergonomics*.)

“With wearable and mobile sensors, we can now monitor the brain activity in realistic settings and even outdoors or in the workplace, so you can do the task just like you would in the real world,” Ayaz says. “Here, we’re emulating the typical environments for gamers, and the groups of teams that they form, to measure multibrain and multimodal biosignals.”

One portion of the project is planned to take place at Nerd Street Gamers, a gaming venue in Philadelphia, where researchers will gather more data on teamwork and game dynamics during an actual *Overwatch* tournament.

“This,” Ayaz says, “is pushing the frontier.”

On a recent March afternoon inside the Behavioral Lab, a team of researchers that includes Ye sets up two gaming stations on opposite sides of the large room, each running *Overwatch*.

For the uninitiated, *Overwatch* is a cooperative, multi-player combat game set in a futuristic Earth that has been threatened by a robot uprising and dangerous political intrigue. Players are first-person “hero shooters” who collaborate with online strangers assigned to their team to restore order by completing tasks within a time limit — earning experience and “loot” along the way. Praised for its colorful, fluid worldscape and accessible gameplay, *Overwatch* became all the rage after its 2016 release by Blizzard Entertainment, earning \$1 billion in its first year and drawing as many as 30 million users globally, according to parent company Activision Blizzard.



WEARABLE MONITOR NO. 1
While the study participant plays the video game, she wears a 1½-inch-wide gray band around her forehead — the fNIRS device. The headband monitors her brain activity as she moves through the game’s virtual universe, including how much oxygen she consumes.

DATA_OUTPUT
The fNIRS and EDA technology generate a dataset of objective information on players’ mental efforts.



IN_PLAY
In the *Overwatch* behavioral experiments, two players navigate their avatars to escort payloads to new destinations. Each participant first plays individually against an A.I. opponent, and then against each other, while biomedical devices record their body’s responses.



WEARABLE MONITOR NO. 2
The study participant also wears an electrodermal activity (EDA) device around the index and middle fingers of her left hand, which collects information on her skin conductance to measure emotional arousal.

The game has figured mightily in international esports competitions with six-figure prize pools and professional teams, including the Philadelphia Fusion. Comcast is heavily involved; its unit Comcast Spectacor paid \$20 million to start the Fusion, one of 20 international city-based teams that compete in Blizzard's *Overwatch* League that launched in 2018. Along with the Cordish Companies, Comcast Spectacor also is building a \$50 million, 65,000-square-foot, 3,500-seat Fusion Arena in South Philadelphia, near Citizens Bank Park, that is scheduled to open in 2021. In addition, Comcast Spectacor is investing in Philadelphia's Nerd Street Gamers, which looks to develop additional esports competition facilities at college campuses and inside Five Below stores in the next few years. The Fusion franchise, next-gen arena and other investments are bold bets on Philadelphia as an esports destination and on the esports industry itself, projected to hit \$1.8 billion in 2022, according to analytics company Newzoo.

Overwatch proved the ideal choice of video game for the experiments, Gray says. "With our company's commitment to the military community and our Philadelphia Fusion competing in the *Overwatch* League," Gray says, "the choice is even more relevant to inform future business decisions."

In the *Overwatch* behavioral experiments, two players navigate their avatars to escort payloads to new destinations. Each participant first plays individually against an A.I. opponent, and then against each other, while biomedical devices record their body's responses.

As Ye defends against the enemy and nudges her payload along, she wears a 1½-inch-wide gray band around her forehead — the fNIRS device. The headband monitors her brain activity as she moves through the game's virtual universe, including how much oxygen she consumes. She also wears an electrodermal activity (EDA) device around the index and middle fingers of her left hand, which collects information on her skin conductance to measure emotional arousal.

This study breaks ground because it doesn't rely solely on subjective self-reporting of the experience, as is typical. The fNIRS and EDA technology generate a dataset of objective information on players' mental efforts.

Comcast will use the data and analysis provided by the DSI team to understand how teams of players, particularly veterans, bond and work together to succeed at the game.

"Serving military customers is a part of Comcast's military engagement value," says Gray. "We're excited to see how the study will inform how we create esports experiences tailored for military veteran gamers."



SIDE FROM ITS VALUE to external partners, the fledgling institute is having a significant influence on the University itself. Suri, the co-leader of DSI, thinks it is driving a sea change in Drexel's culture.

"We're in Philadelphia, in the middle of an industrial corridor," he says. "We need to engage industry in a way that makes the University more forward-looking. In the lab, we do inventions, but we have to translate that into innovation."

Ultimately, DSI projects create immersive, even global learning environments that "train students to be thought leaders," Suri says. "Research normally exists in isolation on campus. DSI is the medium to translate the internal to the external and vice versa, looking at what industry wants and bringing students along with us in a meaningful way, while also bringing industry into our research and classroom spaces."

"That," he says, "is path breaking."

Before the institute had a track record, it had difficulty recruiting students to join projects, says Suri. "Now, we don't," he says. "When they start working, they find it exciting and engaging."

No surprise there, considering the robustness of DSI's collaborations.

In one project that began October 2020, three co-ops and two marketing graduate students have been helping to run a feasibility analysis of a new program that supports clients of Options For All, which provides support services to adults with intellectual and developmental disabilities.

OFA faced a conundrum because it lacked expertise in how to provide enrichment opportunities, particularly during a pandemic, for its older clients who were aging out of the nonprofit's social services programs. "We were aware of the need for a senior program," says Brian Zotti, OFA's vice president and chief of staff. "Our own participants were saying,

'I can't keep up anymore.' But we just don't have that kind of bandwidth."

So, OFA President and CEO Ken Barnes, MBA '11, turned to his *alma mater* for suggestions on how to create virtual and in-person life skills programs for its clients. "The idea of harnessing the power of a top-tier research university to create a solution for our nonprofit," he says, "seemed like a can't-miss decision."

As Zotti put it: "Drexel brings the muscle of expertise."

The Drexel team was able to present OFA with a go-to-market plan that focused on virtual reality experiences and included an impressive demo of a digital tour of the Academy of Natural Sciences of Drexel University, which allows participants with VR goggles or a tablet to virtually stroll the museum's dinosaur exhibits and dioramas.

The result was a platform that OFA would never have envisioned, let alone developed, on its own.

"That's really the magic," Howley says, who was tapped by DSI to consult on the project as a faculty member. "DSI matches the needs of the project to the faculty." As the project developed, experts from the School of Education and College of Computing & Informatics suggested meaningful curricular activities and the VR demo.

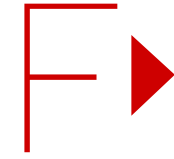
"The clients love this," Howley says. "It's not out of a report. It's not something they read in an article. They're able to talk to the person who wrote the article, the expert in this."

Likewise, Philadelphia-based FMC has partnered with Drexel experts from the Dornsife School of Public Health and LeBow College of Business to study the health impact and community attitudes toward its clean water project in India. FMC is working with a cross-functional team of leaders from Drexel and an NGO named Community Pure Water, as well as a local research agency in India, to install reverse-osmosis water-filtration plants over several years. A focal point of the effort is to conduct community needs assessments and to collect and analyze health and socioeconomic conditions in targeted villages, with scientific and technical support and guidance from Drexel.

"Installing reverse-osmosis water systems is not overly complicated; however, you want to be able to measure impacts and understand if your investments are addressing the community's needs and positively impacting people's lives," says Shawn Whitman, FMC's vice president of government affairs. "If we want to know the actual impact and the return on investment in sustainability, we need experts who specialize in those spaces. This is where DSI brings real value."



RESEARCH NORMALLY EXISTS IN ISOLATION ON CAMPUS. DSI IS THE MEDIUM TO TRANSLATE THE INTERNAL TO THE EXTERNAL AND VICE VERSA, LOOKING AT WHAT INDUSTRY WANTS AND BRINGING STUDENTS ALONG WITH US IN A MEANINGFUL WAY, WHILE ALSO BRINGING INDUSTRY INTO DREXEL'S RESEARCH AND CLASSROOM SPACES.



FROM ITS FOUNDING, Drexel has sought to orient students outward to the world, and toward the future of work. In its recently completed 2020–2030 strategic plan, Drexel spotlights DSI as a template for how the University can actualize its model of maximum real-world relevance.

DSI's foremost mission, after all, is to build relationships that mutually benefit not only external partners, but also a wide swath of faculty and students. Besides offering students chances to solve practical problems, projects also lead to consulting-style research co-ops, résumé-building talking points, and in some cases, full-time employment offers after graduation.

The collaborations also, in turn, inform curricula. A corporate partner might visit classes as a guest speaker or even develop and teach a brand-new course on the latest market trends. Conversely, DSI might contract with a company to create a customized degree program or workforce training for its employees.

In one recent example, the institute expanded on its existing relationship with Malvern-based investment advisor Vanguard Group to create a 2019 course on "Blockchain in Capital Markets" that was jointly developed by John Evans, head of Vanguard's blockchain strategy, and the Pennoni Honors College. In the final class deliverable, groups of students analyzed the impact of blockchain technology on different stakeholders: an issuer of securities, an investor, a bank, a regulator and a technology provider.

"The opportunity to put this subject in front of really bright honors students was really appealing," says Evans, who co-taught the course with an interdisciplinary team of Drexel faculty members who each covered a different aspect of the financial, sociological, engineering and legal aspects of blockchain.

"I put myself in the shoes of the students," Evans says. "It would be really valuable to get perspective from a company like Vanguard in such a nascent space that has such a potential impact, and to get a window into how this was being thought about in real time."

For students, a DSI-managed project provides a rich experience that weaves together teamwork, problem-based learning and career exploration into one. Projects such as the Comcast esports study offer a chance to work on interdisciplinary teams and see a concept through, from inception to final deliverable. "There's ownership," Koulas says. "Students get to learn more about the ins and outs of an organization, and what their products and services are going to look like in the future."

For Ye, her work with industry clients at Drexel has already paid a big dividend: When she graduates in June, she has a job awaiting her as a marketing assistant professor at Clarkson University in Potsdam, New York.

"In my conversations with interviewers," Ye says, "what caught their attention was my experience with DSI." Besides Comcast, she also worked with PECO and Lavazza, among other organizations, and developed and co-taught an undergraduate course called "Research with Industry."

"A lot of the schools I interviewed with expressed interest in having a center like DSI," she says.

_CANCER BY COMMUNITY

A first-of-its-kind report evaluates cancer incidence, screening and mortality data city-wide by cancer type.

THE RACIAL JUSTICE protests and the coronavirus pandemic have illuminated the role that structural racism and socioeconomic factors play in the health of Americans — including cancer rates and outcomes, according to a new report titled, “The State of Cancer in Philadelphia.”



_ANA DIEZ ROUX Roux is the dean and distinguished professor of epidemiology at the Dornsife School of Public Health and director of the Urban Health Collaborative.

The analysis offers key information to public health agencies, policymakers and care providers to inform how best to allocate resources to promote health equity in the city.

Alongside the report published in September, the group also released a community brief, “Cancer and Cancer Health Disparities in Philadelphia.”

Their work is the first of its kind to give a comprehensive interactive overview of cancer incidence, screening and mortality data in Philadelphia by race/ethnicity and sex for different cancer types over the past 10 years.

The researchers found that while incidence and mortality rates for many cancers have been decreasing in the past few years, liver cancer incidence and mortality have increased in men and women. Breast cancer incidence and lung cancer incidence have increased in Black women.

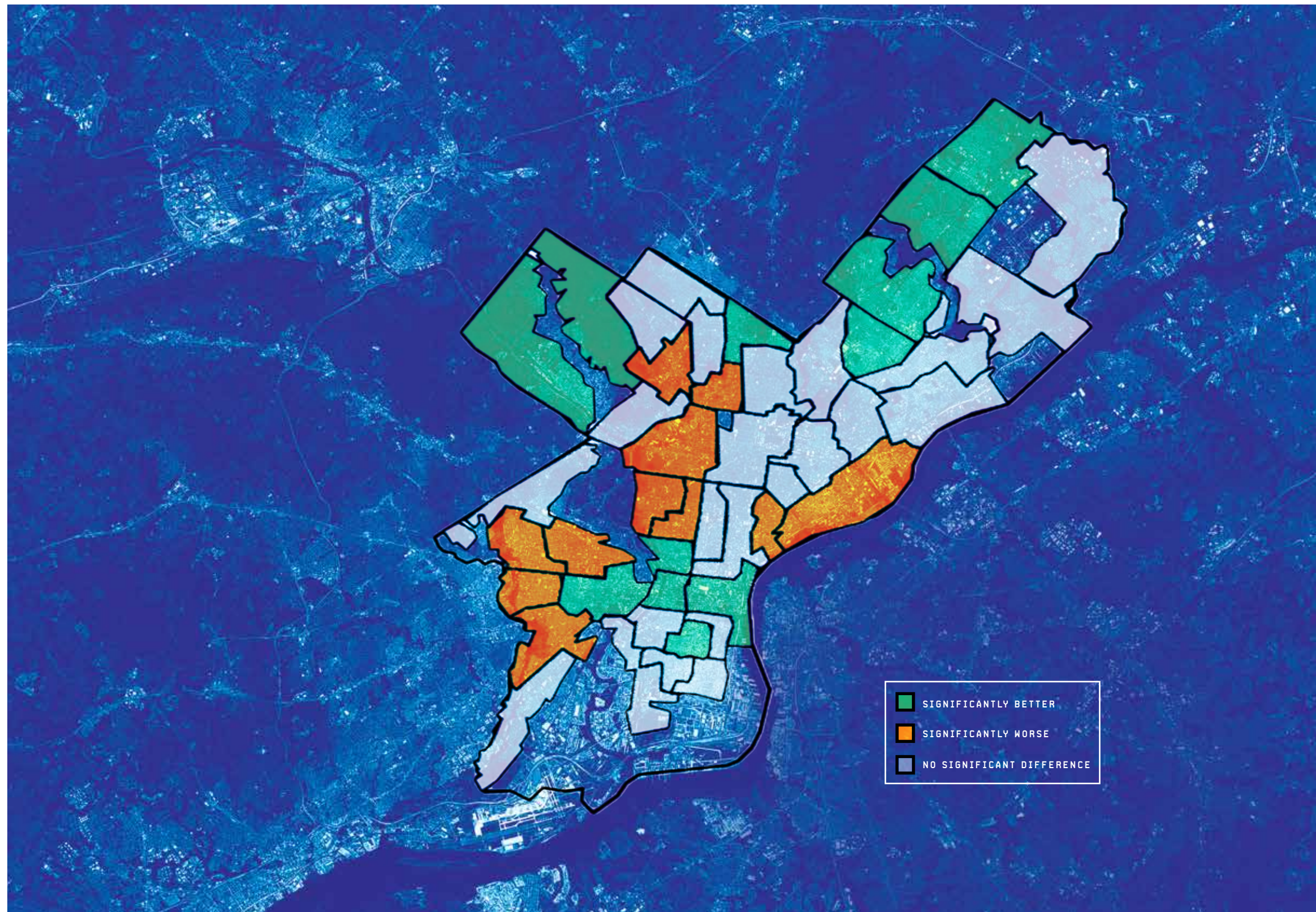
Additionally, racial and socioeconomic disparities persist. Cancer mortality is higher for African Americans than for other racial/ethnic groups and is also higher in neighborhoods with lower levels of education compared to

neighborhoods with higher levels of education.

“COVID-19 has reminded the world of the impact that social conditions, including those linked to race and socioeconomic factors, have on health,” says report contributor and Urban Health Collaborative Director and Dornsife dean Ana Diez Roux. “It’s no surprise that cancer and its risk factors are also strongly socially patterned. Fortunately, we now have hard data to guide efforts to prevent cancer and improve cancer survival in the social groups most affected.”



_CANCER COMPENDIUM “The State of Cancer in Philadelphia” was issued by Drexel’s Urban Health Collaborative, the Philadelphia Department of Public Health, and Fox Chase Cancer Center and was sponsored by Lazarek Cancer Foundation.



CANCER_MORTALITY_COMPARED_TO_CITY_AVERAGE

Cancer incidence, or rates of newly diagnosed cancers, are higher in some Philadelphia neighborhoods compared to the city average, according to “The State of Cancer in Philadelphia” report. Although cancer screening rates are generally high across Philadelphia, both cancer risk factors and cancer screening rates differ by neighborhood. These differences could contribute to differences in cancer mortality across neighborhoods. The Urban Health Collaborative also released an online and interactive data tool called, “Cancer in Philadelphia Neighborhoods” for policymakers, public health agencies and care providers to use to understand cancer, cancer screening and select cancer risk factors in the neighborhoods of Philadelphia.

AUTISM

NUTRITION

DISCRIMINATION

DEMENTIA

_SCREEN TIME & AUTISM

Babies with exposure to high amounts of electronic entertainment and less in-person play were found to have a higher risk of autism-like symptoms later in childhood.



_KAREN F. HEFFLER Heffler is a researcher in the College of Medicine.

autism spectrum disorder-like symptoms later in childhood, though further research is needed to determine a causal connection.

"The literature is rich with studies showing the benefits of parent-infant interaction on later child development, as well as the association of greater screen viewing with developmental delays," says lead author Karen F. Heffler, a researcher in the College of Medicine.

WITH CHILDCARE facilities closed and many parents working from home because of the pandemic, it's no surprise that children's screen time increased during the past year.

But screens still need to be used with caution, a study warns.



Controlling for gender, race, maternal age, and prematurity, the team found that viewing screens at 12 months of age was associated with 4 percent greater ASD-like symptoms.

Researchers at the College of Medicine and Dornsife School of Public Health report that screen time and reduced in-person interaction for babies are associated with greater

These findings, from the first prospective study on the subject, came from reports from caregivers asked about their babies' exposure to screens or books and in-person play during babies' 12- and 18-month well visits.

Controlling for gender, race, maternal age, and prematurity, the team found that viewing screens at 12 months of age was associated with 4 percent greater ASD-like symptoms, and daily playtime with a parent compared to less than daily playtime was associated with 9 percent less ASD-like symptoms.

The authors suggest that parents adhere to the American Academy of Pediatrics recommendation to avoid screen time in children younger than 18 months and limit screens to one hour daily through age 5, co-viewed to help children understand what they are seeing.

_SODA TAX, SHMODA TAX

A year after Philadelphia's tax on sugary beverages, Drexel researchers found the law had minimal to no influence on the average person's consumption.



_AMY AUCHINCLOSS Auchincloss is an associate professor in the Dornsife School of Public Health.

SWEET TRUTH

One year into the soda tax, just 39% of Philadelphians reported drinking fewer sugar-sweetened beverages. This amounted to only about three fewer sugary beverages each month — not a statistically significant difference.

IN 2016, Philadelphia became the first big U.S. city to pass a "soda tax," adding a 1.5-cent-per-ounce tax on sugary beverages.

The tax faced strong opposition from the beverage industry and some grocers. Ultimately, members of Philadelphia City Council supported the tax because it would finance popular family initiatives, namely universal pre-kindergarten and parks-and-recreation programs. Proponents also believed the tax would curb consumption of beverages that have been linked to obesity, diabetes and heart disease.

A year after the tax went into effect, however, Drexel researchers examined its effects and found the law had minimal to no influence on consumption by the average Philadelphian.

The team, led by lead author Yichen Zhong '20, a doctoral student at the Dornsife School of Public Health, used a random-digit-dialing phone survey of adult residents in Philadelphia and in neighboring cities where the tax was not implemented. Participants were asked detailed questions about their beverage consumption, both before the tax took effect



(December 2016 through January 2017) and again approximately one year later (December 2017 through February 2018).

At the one-year mark, 39 percent of Philadelphians and 34 percent of those in surrounding cities reported drinking fewer sugar-sweetened beverages, after controlling for other health behaviors and socio-demographics. This amounted to only about three fewer sugary beverages for Philadelphians each month relative to residents living in surrounding cities — not a statistically significant difference.

"...We're seeing that raising the price of sugary-beverages may not impact consumers who don't drink a lot of soda"

-Amy Auchincloss

The team noted that the study's results could be generalized to an average Philadelphian, however, the results may not be generalizable to subgroups within Philadelphia, such as high consumers of soda and low-income residents.

"We have ample evidence that sugary beverages are connected to type 2 diabetes, obesity, cardiovascular disease, and other health issues, but we're seeing that raising the price of sugary-beverages may not impact consumers who don't drink a lot of soda," says Associate Professor Amy Auchincloss, the study co-author.

_THE BLOOD BOILS

A lifetime of discrimination is associated with a greater risk of high blood pressure among African Americans, statistics show.

AFRICAN AMERICANS who report high levels of unfair treatment throughout their lives were more likely, even when adjusting for other risk factors, to have high blood pressure later in life according to a study from the Urban Health Collaborative at Drexel's Dornsife School of Public Health.

The researchers — including lead author Allana T. Forde, who was a postdoctoral research fellow at the Urban Health Collaborative, and senior author and Urban Health Collaborative Director Ana Diez Roux, dean and distinguished professor of epidemiology at Dornsife School of Public Health — said the study could have implications for treating African American patients.

The authors used survey responses from African American adults living in Jackson, Mississippi, who participated in the Jackson Heart study (the largest investigation of cardiovascular disease in African Americans) and who did not have high blood pressure at the start of the study. Participants were defined as having hypertension if they were taking antihypertensive medication or had a systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg at follow-up visits.

Participants completed a baseline visit between 2000 and 2004 and two follow-up visits — one between 2005 and 2008 and the other between 2009 and 2013. At the time of the baseline visit, patients reported previous experiences of

lifetime discrimination via survey. The researchers counted instances of lifetime discrimination within nine domains — such as in school/training, getting a job or housing, at work, etc. — in which unfair treatment was reported.

The authors found that individuals reporting medium levels (in one to two domains) and high levels of lifetime discrimination (in three to nine domains) had a 49 percent and 34 percent increased risk for hypertension compared to those who reported low levels of lifetime discrimination (zero domains), respectively, after adjusting for gender, age, socioeconomic status and other high blood pressure risk factors.



● high levels of discrimination

34% increased risk for hypertension

● medium levels of discrimination

49% increased risk for hypertension

_CARE FOR CAREGIVERS

An online platform could help support and educate those taking care of people living with dementia.

PEOPLE LIVING with Alzheimer's disease and related disorders can display agitation and aggression that can negatively impact both themselves and their caregivers, who are typically family members.



_LAURA N. GITLIN Gitlin is dean and distinguished university professor in the College of Nursing and Health Professions.

To address this issue, the National Institute on Aging awarded nearly \$4 million to Laura N. Gitlin, distinguished professor and dean of Drexel's College of Nursing and Health Professions, and her University of California colleague Helen Kales to study the impact of an easy-to-use, online platform called the WeCareAdvisor. According to Gitlin, the trial will be enrolling caregivers across the country to achieve geographic, race and ethnic diversity in the caregiver sample.

The WeCareAdvisor platform provides caregivers with education about dementia, daily tips for managing stress and a systematic approach for describing, investigating, creating and evaluating strategies (known as the DICE approach). It also offers caregivers access to knowledge about behavioral symptoms when they need it and as behaviors occur.



THE 'DICE' APPROACH

One of the tools that the WeCareAdvisor platform utilizes is a systematic approach, called "DICE" for DESCRIBING, INVESTIGATING, CREATING & EVALUATING strategies to better manage behavior in dementia patients.

"Family caregivers are rarely informed about behavioral and psychological symptoms which are common clinical symptoms in dementia, nor do they have opportunities to learn about specific proven non-pharmacological strategies that can prevent, reduce and/or manage these symptoms," says Gitlin.

Preliminary evidence from pilot research suggests that use of the WeCareAdvisor reduces caregiver distress, enhances their confidence and may contribute to fewer behavioral symptoms.

MISINFORMATION

NUTRITION

EPIDEMIOLOGY

_VAX TALES ON THE INTERNET

Want to convince the public about the safety of vaccinations? Consider storytelling.



_PHILIP MASSEY Massey is an associate professor of community health and prevention in the Dornsife School of Public Health.

THERE'S BEEN a resurgence in misleading anti-vaccination messages and related misinformation spreading through social media, and public health communicators need to be strategic to combat it, says Philip Massey, an associate professor of community health and prevention in the Dornsife School of Public Health.

"By studying what makes these messages so effective online, we can improve fact-based, pro-vaccination messaging aimed at improving public health," he says.

The key is to capture attention with storytelling. Massey is senior author of a National Cancer Institute-supported study published in late 2019 in the journal Health Education and Behavior that found that health campaigns on social media aimed at increasing human papillomavirus (HPV) vaccination may see greater success if they blend information with a narrative. In addition to Massey, co-authors include Matthew D. Kearney and Michael Hauer of Drexel, and Preethi Selvan and Amy E. Leader of Thomas Jefferson University.

The benefits of the HPV vaccine in prevent-

ing a number of cancers in boys and girls are well-documented, yet the anti-vaccine movement has gained ground in recent years through "bots" and efforts by groups to spread false information through online communities.

Drexel researchers analyzed English-language Instagram posts about HPV vaccination and found that although the majority of posts were pro-vaccine (56 percent), anti-vaccine messages received much higher engagement, including more "likes."

"By studying what makes these messages so effective online, we can improve fact-based, pro-vaccination messaging aimed at improving public health."

-Philip Massey

Most anti-vaccine messages featured a narrative structure, whereas only 28 percent of pro-vaccine posts featured personal narratives or other story elements. Pro-vaccine messages (72 percent) typically shared actionable information about the vaccine instead.

The takeaway? Pro-vaccine posts may draw greater attention to their information and evidence if they use a more narrative structure to disseminate their message.

_LI'L EATS

PARENTS CAN play an important role in helping their children adopt healthier eating habits, but encouraging children to eat more vegetables and cut down on sugary treats isn't easy.

So then-doctoral student Britt Evans at Drexel's Center for Weight, Eating, and Lifestyle Science (WELL Center) developed "Project PICNIC" as her dissertation project.

Project PICNIC (Parent Skills Coaching to Nourish Children) is designed to help parents of 2-10 year-olds who are having difficulty promoting a healthier diet for their child. The program uses video-conferencing software to provide parent coaching from WELL Center counselors on skills and strategies to manage challenging situations at family mealtimes.

"Most types of treatment require the parent or family to come into an office to learn new strategies, then go home and try to use them on their own, without any guidance or support," says Evan Forman, a psychology professor in Drexel's College of Arts and Sciences and director of the WELL Center, who served as a faculty mentor to Evans. With video conferencing "the coaching they receive is going to be better tailored to exactly those challenges that a parent faces at mealtimes, because the coach is observing the interactions in real-time," he says.

Results from the proof-of-concept program indicated that it was feasible to provide effective video-conference coaching at the dinner table and that parents were highly satisfied with the program.

_LIFESPANS IN LATIN AMERICA

A study of life expectancy in Latin America highlights the need for policies that improve circumstances for the region's poorest neighborhoods.

A STUDY FROM the Dornsife School of Public Health found wide-ranging differences in lifespans in six major Latin American cities; in particular, researchers found higher differences in life expectancy at birth within cities than among cities.

For example, in Santiago, Chile residents of the areas with the highest life expectancy live 18 years longer, on average, than residents of areas with the lowest life expectancy.

"Inequality harms everyone," says lead author and Assistant Professor Usama Bilal.

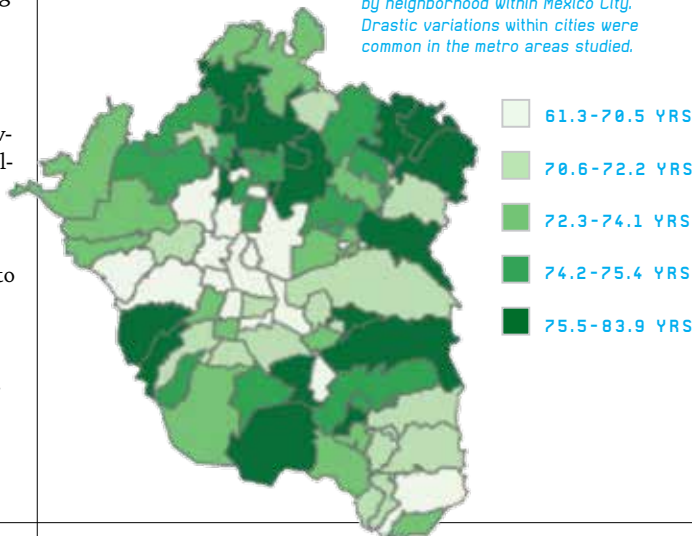
The findings, published in The Lancet Planetary Health from researchers at the Salud Urbana en América Latina (SALURBAL), or Urban Health in Latin America project at Drexel Dornsife School of Public Health, are the latest among growing efforts by the group to evaluate how environment and public policies influence the health of the 80 percent of Latin Americans who reside in cities.

Researchers calculated life expectancy at birth by gender for six metropolitan locations — Buenos Aires; Belo Horizonte, Brazil; Santiago, Chile; San Jose, Costa Rica; Mexico City; and Panama City. They did this by mining each country's census and vital registration data for stats on socioeconomic status measures, death rates, gender and other population metrics.

The health disparities across neighborhoods in Latin American cities coincide with other inequalities. Among the 20 countries in the world with the highest wealth gap, eight of them are within Latin America.

"These stark differences in health across neighborhoods arise from differences in social circumstances and physical environments that can be addressed through policy," says SALURBAL principal investigator Ana V. Diez Roux, dean of the Dornsife School of Public Health. "They highlight how health is affected by much more than health care."

_MAPPING MORTALITY Life expectancy varies significantly by neighborhood within Mexico City. Drastic variations within cities were common in the metro areas studied.



_SAFE, WALKABLE...HEALTHY

More proof that where we live and how the built environment is designed matters for human health.

GEOGRAPHY MATTERS

This study is one of the first of its kind to incorporate knowledge about how the characteristics of an individual's neighborhood, such as its walkability, violent crime and availability of healthy food, may influence the risk of chronic kidney disease and poor blood sugar and blood pressure control, especially in urban areas.

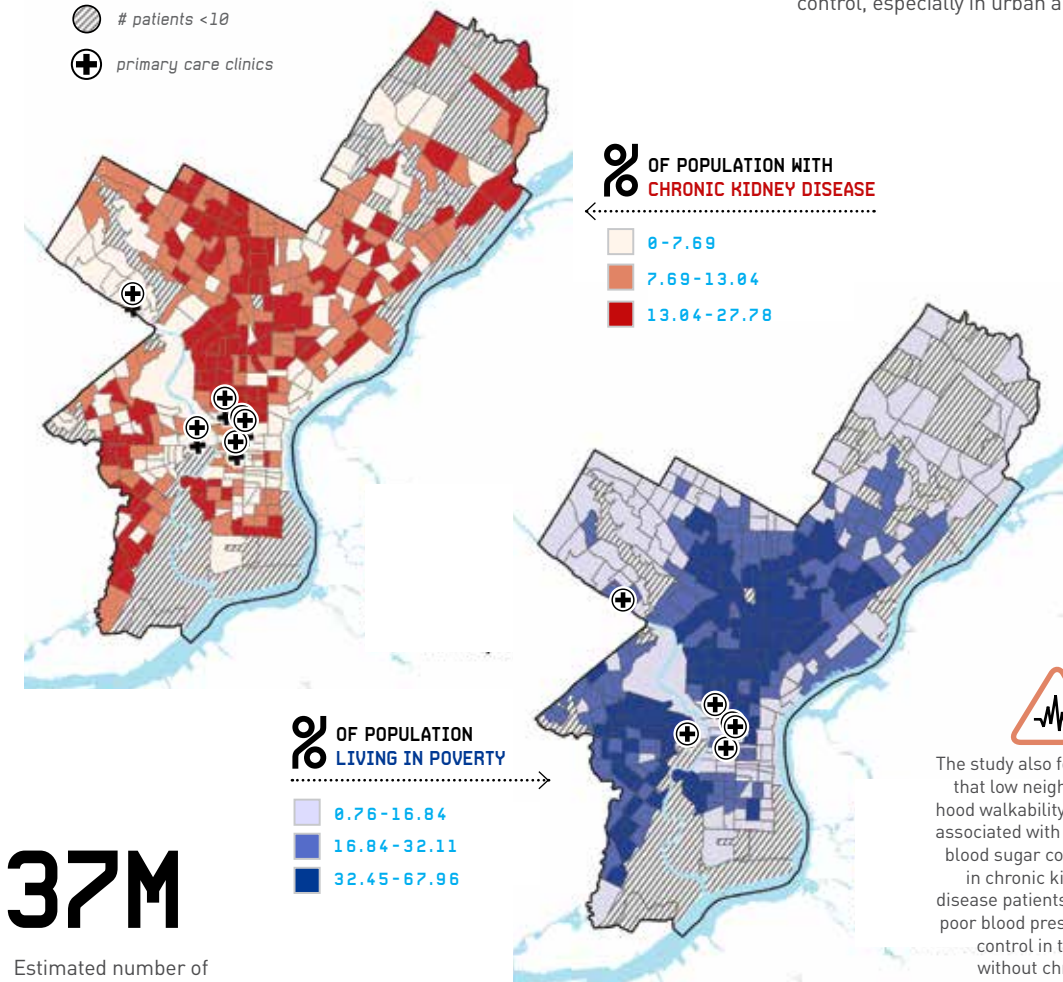
YOUR NEIGHBORHOOD'S overall socioeconomic status may influence your risk of chronic kidney disease, according to a study published in SSM Population Health by researchers from the Dornsife School of Public Health.

In a study of over 23,000 adult Philadelphians seen in a primary care practice in 2016 or 2017, the authors found that those living in low socioeconomic status neighborhoods (factoring in neighborhood income, educational attainment and occupation), were more likely to have kidney disease than those living in higher socioeconomic status neighborhoods.

The authors adjusted for individual age, race, sex and insurance type.

"Our main finding, that people who are living in neighborhoods with the fewest financial resources are at highest risk for kidney disease, should be a call to health providers to integrate knowledge about their patients' environments into tailored care processes," says senior author Meera Harhay, an associate professor of medicine at the College of Medicine and Dornsife School of Public Health.

"Policymakers should also direct resources to these at-risk communities so that we can identify kidney disease earlier and promote better health in vulnerable populations," she recommends.



37M

Estimated number of U.S. adults suffering from chronic kidney disease. It's believed that nine out of 10 cases go undiagnosed. Chronic kidney disease is characterized by damaged kidneys that are unable to adequately filter waste and excess fluids out of blood.

"This study offers tools to help identify communities at higher risk of kidney disease. When kidney disease is detected early, some of its worst outcomes can be delayed or avoided entirely."

-Meera Harhay, MD

The findings of this research are valuable to the U.S. Department of Health and Human Services' Advancing American Kidney Health Initiative, whose goals include reducing the number of Americans in end-stage renal disease by 25 percent by 2030.

[QUICK STUDIES ON]

RACIAL INJUSTICE

_by Jen Miller

Outrage over police killings of Black citizens in the summer of 2020 spurred researchers and the University to respond with a novel fund for "rapid response" scholarship.

IN THE SUMMER OF 2020, as citizens from coast to coast marched in protest of George Floyd's murder, Drexel's Office of Research & Innovation sought to respond to the national upheaval with research and scholarship. To support this work, the University announced a novel competitive seed fund initiative called Rapid Response Racial Equity Awards, designed to fund short timeframe inquiry into understanding systemic racial inequality in the United States.

The new fund, totaling \$100,000, was inspired by a similar "rapid response for COVID-19" fund created weeks earlier, which proved tremendously successful in fueling a number of patents, follow-up grants and prototypes related to the pandemic (see full story on page 34).

Executive Vice Provost for Research and Innovation Aleister Saunders said the initiative recognizes that racial inequality is as pressing a social challenge as the pandemic. "The scourge of discrimination and racial inequality must be addressed head-on and we must seize this unique moment in history," he says. "It is our intention that this will bolster our scholars' efforts to use their scholarship to fight inequity, eradicate racism and address systemic inequalities."

Twenty-two faculty and professional staff from nine colleges and schools (plus one institute) received funding through the initiative. Some projects tackle the internal culture at Drexel, such as a racial equity audit of the School of Education, and a study of inequities faced by Black faculty and students on campus.

Others, such as those highlighted here, are aimed at advancing society's understanding of racial and inequities in health care, policing and education.

PREVENTING AND MITIGATING RACIAL BIAS IN MACHINE LEARNING SOFTWARE

At least in theory, algorithms based on machine-learning remove human biases from decisions by removing humans from the equation. But in reality, biases end up baked into outcomes, because humans create the algorithms upon which machine learning is based.

There are numerous accounts, for example, of facial-recognition software and object-detection technology misidentifying dark-skinned people. One report from Georgia Tech researchers even posits that dark-skinned pedestrians could be more likely to be hit by self-driving cars. And a recent *ProPublica* report found that algorithms used to predict which criminals are most likely to re-offend often assessed Black people at higher risk than white people, even if the white person committed a more serious crime.

Orakwue Arinze, professor of decision sciences and management information systems (MIS) in the LeBow College of Business, is working on a project to prevent and mitigate racial bias in machines by modifying the Cross-Industry Standard Process for Data Mining (CRISP-DM), a popular methodology for data analytics and machine-learning development. The goal is to make modifications that are easy to understand, practical and demonstrably effective in helping developers de-bias their applications.

He chose to work with something already in use because it doesn't require creating a new framework. Instead, it adapts an already established framework to take the biases — and biased decisions they produce — out of the equation.

"While it is possible to create a brand-new methodology for developing machine-learning systems, piggybacking on the popular CRISP-DM methodology increases the probability of adoption by data scientists," he says.



The Intellectual Green Book:

Tracking Self and Community Preservation Tactics Among Black Women and Black Non-Binary Individuals in the Nonprofits Arts Sector

IN 1936, VICTOR HUGO Green wrote *The Negro Motorist Green Book*, which became an annual guide book for Black road trippers directing them toward hotels, restaurants, repair shops and gas stations that were safe for Black travelers, and spotlighting which towns to avoid.

Brea M. Heidelberg, associate professor and program director in the Entertainment & Arts Management program in the Westphal College of Media Arts & Design, argues that a sort of "Intellectual Green Book" exists in the form of informal networks of guidance intended to combat the intersectional oppression that Black women and Black non-binary people face in the nonprofit sector. She is undertaking an exploratory study to demonstrate its existence and to begin investigating how it is created, maintained and used.

Organizations like the Arts Administrators of Color Network and Women of Color in the Arts already work on these issues "but the process and impact hasn't been theorized and researched before," Heidelberg says. "My research is based upon the premise that this specific type of green book exists, but that it hasn't been fully articulated yet."

The project seeks to answer questions such as, how do Black women and Black non-binary individuals in the nonprofit arts make career choices? Does one aspect of their identity take precedence when making these decisions? What types of information do they get prior to making that decision? How do they cope with workplace trauma? How do Black women and Black non-binary individuals in the nonprofit sector use internalized gatekeeping tactics on others?

"The Intellectual Green Book may be preventing Black women and nonbinary individuals from leaving the cultural workforce by providing a place to process, heal from and learn how to combat workplace violence," she says.

EXAMINING RACIAL DIFFERENCES IN THE LINK BETWEEN SCHOOL SUSPENSIONS AND ARRESTS

Stark racial disparities in the juvenile justice system are already well known. Nonwhite children tend to receive harsher treatment and outcomes in juvenile court. But what mechanisms create these disparities?

One potential factor: school discipline, which could have life-long implications.

"Research shows that being arrested or detained during youth or adolescence can harm prosocial development and may increase the likelihood of repeated crime and punishment into adulthood," says Kathleen Powell, a postdoctoral fellow in Criminology and Justice Studies in the College of Arts and Sciences. "Identifying the link between school suspensions and justice system involvement for youth and adolescents ... is thus critically important to understanding how the justice system can contribute to social inequalities."

The project looks at how correlations between suspension and the justice system vary by race, and in doing so, asks how a child's self-identified race or ethnicity moderates the relationship between being suspended and arrested or receiving a criminal sentence.

Powell's analysis will use quantitative methods and NLSY97 data, a longitudinal survey collected by the U.S. Bureau of Labor Statistics that includes a sample of participants who were ages 12 to 16 as of December 31, 1996, and were interviewed annually between 2007 and 2011 and biannually to the present.

"Not only is the sample large and national in scope, but the data also capture the experiences of a cohort of youth coming of age during a historical moment in which juvenile justice and school discipline policies became increasingly punitive and zero-tolerance, respectively, in nature," Powell says.



MULTI-CITY POLICY SURVEILLANCE TO IDENTIFY POLICY SOLUTIONS TO LAW ENFORCEMENT REFORM

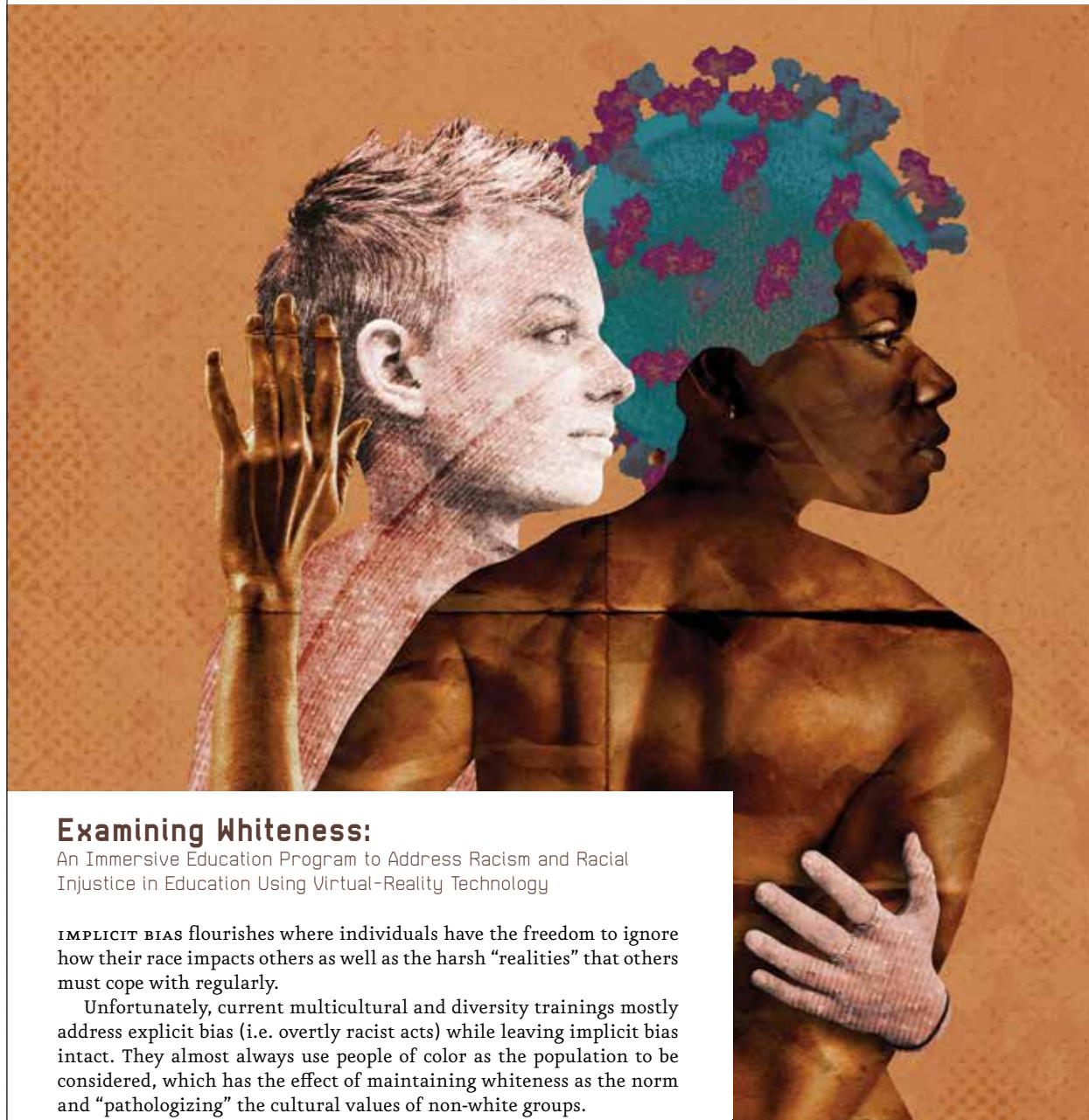
As activists put forth new calls for police reform, Associate Professor of Community Health and Prevention Amy Carroll-Scott and Jennifer Kolker, clinical professor and associate dean for public health practice and external relations, both in the Dornsife School of Public Health and the Urban Health Collaborative, decided to focus their already successful policy surveillance study on examining law enforcement reform efforts in U.S. cities.

“Since George Floyd’s death, the nation has been more supportive of efforts to better understand and develop solutions to prevent these fatal encounters between police and Black individuals [and other residents of color],” says Carroll-Scott. “What we need to know is whether calls for reform are actually resulting in reform. And if so, what are best practices that can be adopted across police systems.”

Between 2017 and 2019, Carroll-Scott and Kolker’s team at the Policy & Community Engagement Core of the Drexel Urban Health Collaborative did similar policy surveillance on seven cities, including Philadelphia. Researchers looked for city policy solutions related to the social determinants of health (i.e., housing, education, the environment) to support cross-sector health-equity strategies, and created cross-city policy briefs that were distributed in the fall.

This new study replicates that existing methodology to identify and monitor policies emerging between May 2020 and May 2021, but focused on policies addressing law enforcement reform. Preliminary findings have revealed policies related to law enforcement transparency and accountability; bans on no-knock warrants; de-escalation tactics in protest situations, pilot police deflection, diversion, or co-responder models; body camera use and footage release; and training programs related to implicit bias and de-escalation protocols. Final results will compare successes and challenges across cities.

_ ONLINE
For the full list of award recipients, visit exelmagazine.org.



Examining Whiteness:

An Immersive Education Program to Address Racism and Racial Injustice in Education Using Virtual-Reality Technology

IMPLICIT BIAS flourishes where individuals have the freedom to ignore how their race impacts others as well as the harsh “realities” that others must cope with regularly.

Unfortunately, current multicultural and diversity trainings mostly address explicit bias (i.e. overtly racist acts) while leaving implicit bias intact. They almost always use people of color as the population to be considered, which has the effect of maintaining whiteness as the norm and “pathologizing” the cultural values of non-white groups.

Three College of Nursing and Health Professionals researchers — Ebony White, assistant clinical professor in counseling and family therapy professionals; Kimberly McClellan, assistant clinical professor in undergraduate nursing; and Arun Ramakrishnan, director of research labs — are creating an immersive learning course titled, “Examining Whiteness,” that “flips” that script by instead directing the examination of whiteness, with the help of virtual-reality scenarios.

Immersive learning and virtual-reality technology are key to their approach because immersive experiences have been shown to be effective in reducing implicit bias by encouraging empathy and engagement.

The virtual-reality scenarios they are creating will enable participants to take part in two different ways. In the first scenario, they can simply be an observer to how bias plays out in various situations, while data is captured regarding their reactions. The second will allow them to experience the scene as one of the characters, accelerating understanding of how bias affects different demographics.

A SIMULATION-BASED PEER INTERVENTION TRAINING PROGRAM TO INCREASE ACTIVE BYSTANDERSHIP AMONG A SAMPLE OF POLICE OFFICERS

When Minneapolis police officer Derek Chauvin knelt on George Floyd’s neck until he died, three police officers did nothing to stop him.

This is called passive bystandership, and it is such a problem in American policing that many departments have enacted peer-intervention policies requiring officers to intervene when their colleagues make mistakes or engage in serious misconduct. However, even the most robust programs have not proven to be effective.

Robert J. Kane, department head and professor of criminology and justice studies at the College of Arts and Sciences, is conducting a pilot study to develop and test a police officer peer-intervention training that treats police officers like clinicians by using the same type of simulation deployed to teach doctors, nurses, and airline flight crews (though never before practiced on law enforcement).

The seven- to 20-minute simulation immerses students, who will be in their final week of field training, in disorientating hypothetical situations, most of which “will involve a more senior officer escalating the encounter to the point where they use excessive force on the person they’re dealing with,” says Kane. During simulations, they’ll measure the degree to which the students intervene, if at all.

Students will be debriefed by instructors and peers, and a facilitator will guide them through a discussion of what they were thinking and/or feeling in the simulation so they can better understand their actions, and identify strategies needed to work through a similar situation in the future.

COVID-19 + Race/Ethnicity = ?

Are We Really All In This Together?

WHILE WE ALL FEEL impacted by the pandemic, statistics show that COVID-19 is disproportionately decimating communities of color. Early in the pandemic, in most of the 33 states (plus the District of Columbia) that reported race and ethnicity as part of their COVID-19 cases and deaths, Black people made up a higher proportion of confirmed cases and deaths relative to their share of total population. In six of the 26 states reporting data for Hispanic people in April 2020, these communities made up a greater share of confirmed COVID-19 cases compared to their share of the total population.

“The underlying, well-known health, social and economic disparities present in communities of color are being magnified by the pandemic,” says Loni Philip Tabb, associate professor of biostatistics in the Dornsife School of Public Health. She is co-principal investigator with Scarlett Bellamy, professor and associate dean for diversity, inclusion and faculty development at Dornsife and Leslie Ain McClure, professor and chair of epidemiology and biostatistics.

The researchers, including recent master’s graduate Kara Beck ’21, are using publicly available county-level data to adjust for a lack of consistency in reporting race and ethnicity related to COVID-19 health outcomes. They hope their work will close the gap, for the sake of future researchers, of peer-reviewed, scientifically rigorous evidence that definitively assesses these relationships and how they vary across the country.



POLICING & HEALTH: THE EFFECTS OF LAW ENFORCEMENT ENCOUNTERS AMONG QUEER PEOPLE OF COLOR

Disparities in policing aren’t based on race alone, and yet there’s a dearth of work examining law enforcement through an intersectional lens, says Jason Orne, assistant professor of sociology in the College of Arts and Sciences, and Caroline Voyles, PhD candidate and field researcher in Drexel’s Urban Sexuality Lab.

Their work examines a long-standing connection between policing and queer people of color, a population impacted by increased policing in communities experiencing homelessness, gentrification, eviction and other urban planning processes. With the help of student lab members including Nina Olney (BS ’21), Mariah Mennano (MPH ’21) and Sofia Argibay (MPH ’22), their goal is to identify and shine a spotlight on the health consequences of police oppression on this population.

By using the National Longitudinal Study for Adolescent Health, which has followed 20,000 adolescents who were in 7th to 12th grade during the 1994–1995 school year, the study will examine the relationship between sexuality, race and policing on mental and physical health through three aims:

- To identify how health outcomes relate to sexual and racial identities and determine which health outcomes are most strongly related with minority status.
- To examine how the effects of police encounters vary by sexual and racial identities and mediate the relationship between health outcomes and sexual minority and racial minority status.
- To determine a sociological theory of the effect of policing through this intersectional lens. This aim also prepares the study as possible pilot data for a future National Institutes of Health grant submission.

_ THE COVID-19 RESPONSE

Why does the SARS-Cov-2 coronavirus cause some people mild or no symptoms, yet ravage others? Medical researchers in Drexel's College of Medicine and Tower Health are part of a national patient study to better understand how the disease impacts people differently.

DREXEL'S COLLEGE of Medicine and Tower Health are among 10 leading medical institutions nationwide involved in a study funded by the National Institutes of Health's National Institute of Allergy and Infectious Diseases to answer questions about variations in immune responses to COVID-19.

The "ImmunoPhenotyping Assessment in a COVID-19 Cohort" study, or IMPACC, aims to advance understanding of diagnosis, biosignatures associated with symptoms, and antibodies that predict protection, in an effort to develop effective treatments.

Drexel and Tower Health researchers are tracking adult COVID-19 patients at Tower Health's area hospitals as part of the national study of approximately 2,000 patients undergoing treatment for COVID-19.

Beginning in the first 36 hours of patient admission, researchers will track study participants in the hospitals for up to 28 days. The tracking will include DNA samples from blood and nasal swab samples during medical care. Researchers will also get samples during patients' follow-up appointments every three months, for up to a year, to assess their recovery and level of immunity, if any.

The research will also compare the severity of the disease with amounts of the virus detected. Researchers hope this longitudinal data can help in improving care for patients with COVID-19.

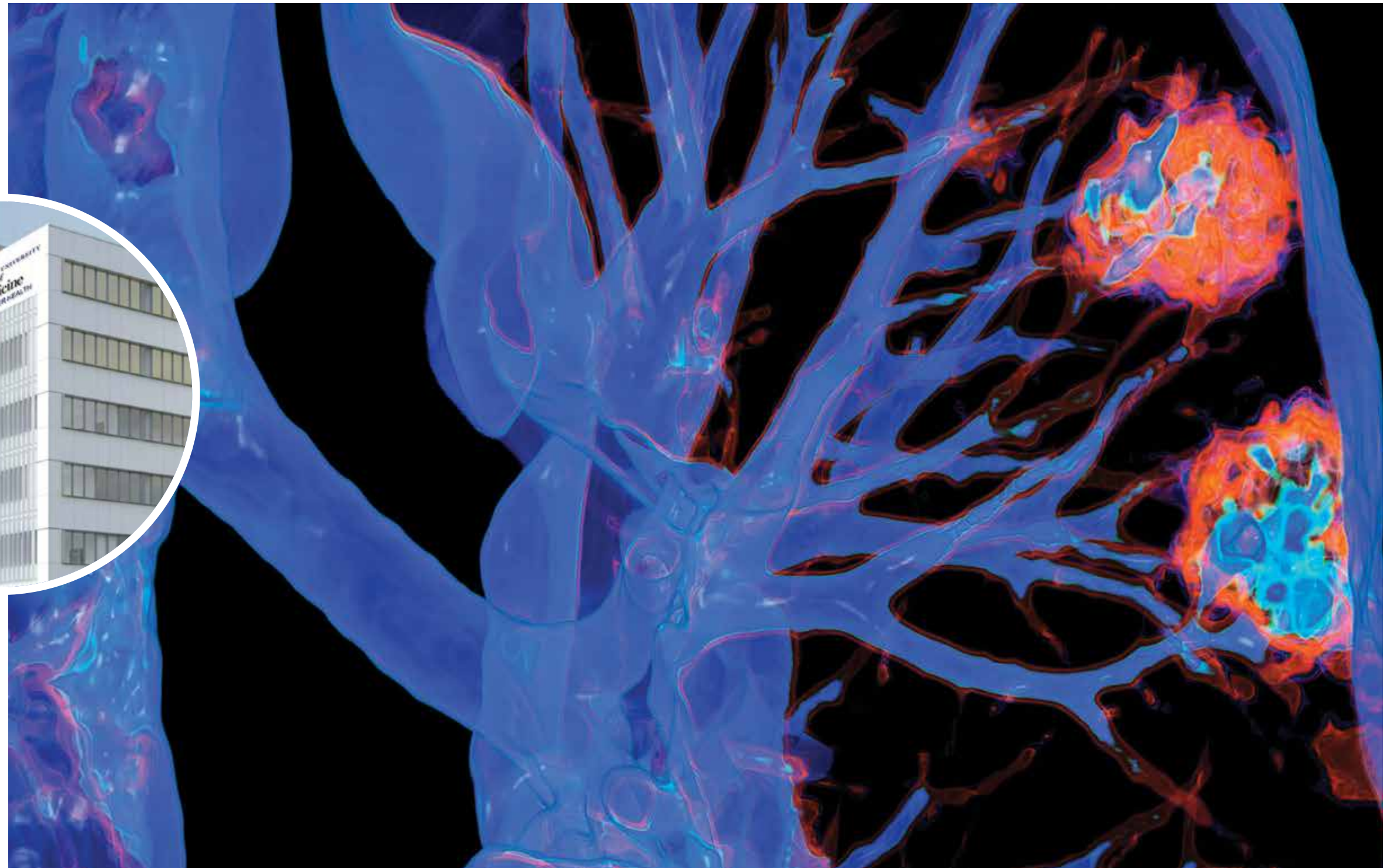


_ ELIAS EL HADDAD
El Haddad is a professor in the Department of Medicine, Division of Infectious Diseases & HIV Medicine at the College of Medicine, as well as director of the MD/PhD dual degree program. He is an immunologist and cell biologist who studies human immunology, systems biology, infectious disease pathogenesis and vaccinology.



"There is a big gap in our understanding of why the virus can lead to a range of symptoms from asymptomatic to severe complications and death," says study co-principal investigator Elias El Haddad, a professor in the Division of Infectious Diseases & HIV Medicine in the College of Medicine. "We expect that in this study we will be able to identify biomarkers that can predict a specific COVID-19 symptom. This will help inform us on the nature of treatment implemented."

COVID_EFFECTS
Colored computer tomography [CT] scan of lungs affected by COVID-19 pneumonia (indicated in red).



Drexel has a number of important partnerships with Tower Health, a six-hospital system with locations in the Philadelphia area. Under a 20-year academic affiliation, Drexel and Tower Health will begin educating Drexel medical students at a new location near Tower Health's flagship hospital in West Reading, Pennsylvania, starting late 2021. Drexel and Tower Health also co-own St. Christopher's Hospital for Children in Philadelphia.

CLINICAL CARE

ADDICTION

DRUG DELIVERY

PEDIATRICS

_ SPEAKING ABOUT SYMPTOMS

Doctors and their patients both benefit from using a range of diagnostic labels to discuss patients' experiences with autoimmune conditions.



_ KELLY JOYCE Joyce is a professor of sociology in the College of Arts and Sciences and the founding director of Drexel's Center for Science, Technology and Society.

WHEN ANALYZING how people who live with autoimmune illnesses communicate about their conditions, professor of sociology Kelly Joyce in the College of Arts and Sciences found it's helpful for patients experiencing symptom ambiguities and shifting diagnostic labels, as well as for the physicians treating them, to use both broad diagnostic terms, like "autoimmune disease," as well as narrow ones, such as "lupus" or "MS."

Drawing on 45 in-depth interviews with people who live with autoimmune illnesses, Joyce's research showed that both types of diagnostic classifications are integral to diagnostic work and explaining illness experiences for people with these conditions.

More than 80 illnesses are considered to be autoimmune or autoimmune-related, and more than 50 million people in the United States live with these conditions. Though autoimmune illnesses vary widely, the common thread is an immune response

that attacks healthy cells, tissue and/or organs. Joyce's study suggests that the label "autoimmune" provides, at minimum, some understanding and a scientific explanation as to what is happening to patients and how to manage symptoms, though exact diagnosis may be a moving target. Even within a narrow diagnostic category like Multiple Sclerosis, for example, there is enough variation in illness experiences that using a broad category term like autoimmune helps patients see what they have in common.

In light of her findings, Joyce suggests clinicians should consider presenting patients with both broad and narrow disease classifications when discussing autoimmune diagnoses initially and over time.

Within medicine, clinicians and researchers use the language of lumping and splitting to distinguish between two valuable diagnostic classification practices. The process of lumping creates broad categories and emphasizes connections."

-Kelly Joyce

_ AN OVERDOSE ALERT SYSTEM

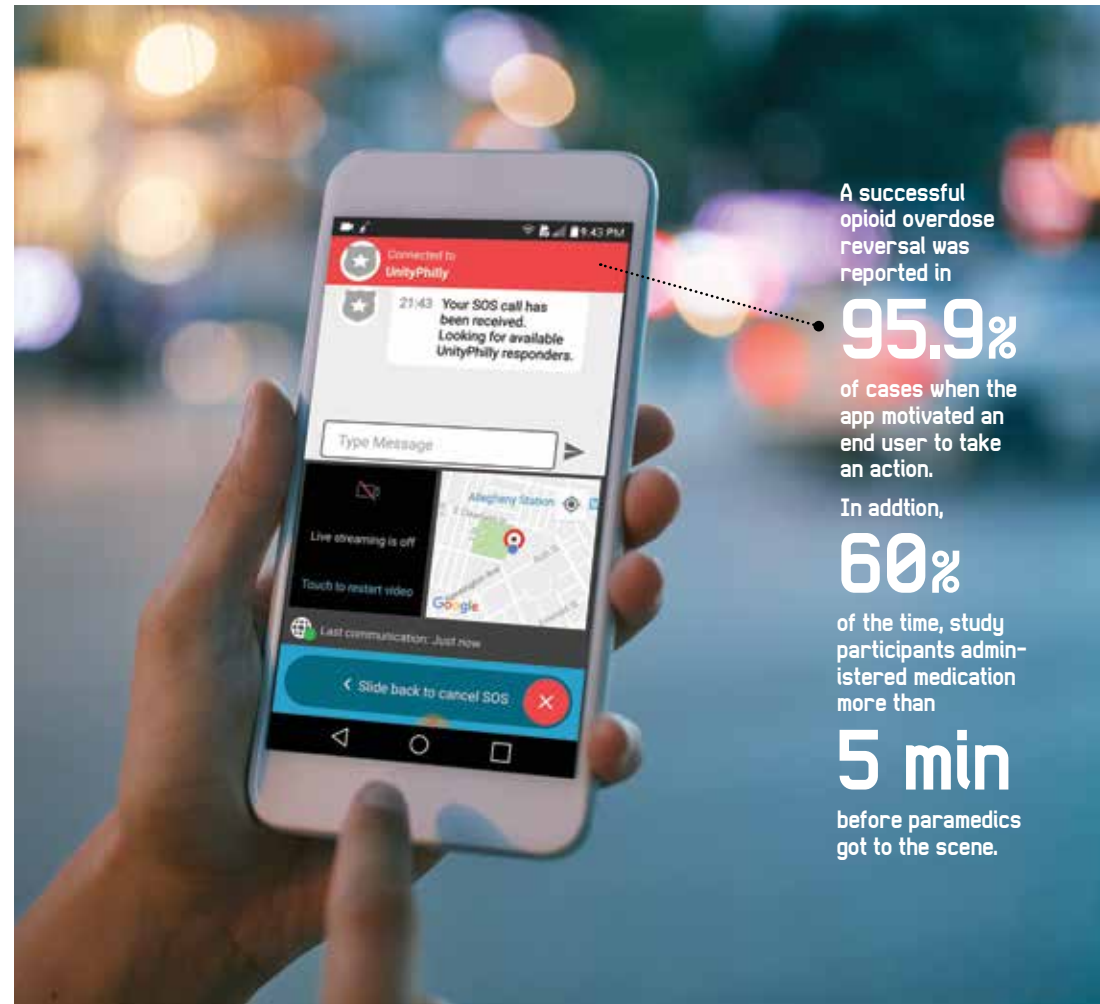
Can an app alert save a life? The UnityPhilly app from the Dornsife School of Public Health empowers community members to respond to opioid overdoses in less time than it takes an ambulance to arrive.

EQUIPPED WITH medication and a smartphone app, community members can save lives in the fight against America's opioid crisis, according to a pilot study out of the Dornsife School of Public Health. Researchers developed an app called UnityPhilly that allows enrolled participants to signal and respond to opioid overdoses as laypersons. During a year-long observational study that concluded in February 2020, 112 adult Philadelphians, 57 of whom use opioids, reported 291 suspected overdoses and alerted nearby volunteers using the app.

In the 74 cases deemed overdose emergencies, a successful reversal was reported in 95.9 percent of cases when app users either witnessed an overdose, signaled an alert in the app and then administered naloxone themselves, or received an alert via the app and traveled to the location to administer naloxone. Naloxone medication instantly blocks opioid receptors, reversing an overdose.

In nearly 60 percent of the cases, study participants administered the medication more than five minutes before paramedics arrived on the scene.

"By empowering community members with these tools, we strengthen the 'chain of survival,' and keep people alive until EMS or other medical personnel administer further aid," says Stephen Lankenau, a professor and associate dean for research at the Dornsife School of



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_ STEPHEN E. LANKENAU Lankenau is associate dean of research and a professor in the Department of Community Health and Prevention in the Dornsife School of Public Health.

Public Health who co-lead the study.

All study participants were trained in how to use the app, to give rescue breathing and to administer naloxone, and were then provided with two doses of the medication. Every time someone signaled an alert by pressing the "SOS" button in the app, the app also alerted EMS via 911 so they could follow up with their protocol, even if a layperson already

responded to the alert.

The study focused on four Philadelphia ZIP codes, with participants recruited in the Kensington neighborhood, which experiences higher drug use than other areas of the city. The authors will next look at a city-wide study to test if the app can be scaled for all of Philadelphia.

Philadelphia has the highest per capita overdose mortality rate among large U.S. cities.

_ STOPPING SYMMETRY

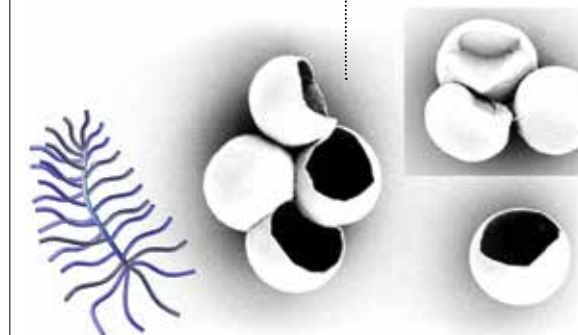
RESEARCHERS AT Drexel who study the formation of crystalline materials have shown that it's now possible to control how crystals grow — including interrupting the symmetrical growth of flat crystals and inducing them to form hollow crystal spheres. The discovery is part of a broader design effort focused on the encapsulation of medicine for targeted drug treatments.

"What we've discovered is a way to chemically manipulate the macromolecular structure so that this translational symmetry is broken when the molecule crystallizes," says Christopher Li, a professor in the College of Engineering whose research in the Department of Materials Science and Engineering has centered around engineering polymer structures for special applications. "This means we can control the overall shape of the crystal as it forms — which is a very exciting development, both for its scientific significance and the implications it could have for mass production of targeted therapies."

The technique Li uses to compel what would normally be a flake-like crystal to draw itself up into a sphere builds on his previous work with polymers that look like brushes and polymer crystals formed from emulsion droplets. Incorporating these pliable "bottle-brush" polymers as the structural system of the crystal allows Li to shape its growth by adjusting the "bristles" of the brush.

Li's team also reports on how to pause the formation of the crystal, leaving holes in the sphere that could be useful for inserting a medicinal payload during the manufacturing process. Once filled, it can be closed with polymers tailored to help direct it to its target in the body, for example the tumor of a cancer patient.

"This spherical crystallography manifests in robust structures that we see in nature from egg shells to virus capsids, so we believe it is the ideal form to survive the rigors of delivering medication in the body."



CRYSTALS FOR CAPSULES

By adding more polymer "bristles" to bottle brush polymers (left), researchers have discovered a way to initiate and pause the self-assembly of crystals from solution. The crystals could one day be used to encapsulate medicine for targeted drug therapies.

_ THE GENDER MYTH IN MEDICINE

Gender bias and discrimination against women are still pervasive in female-dominated medical specialties like pediatrics, and common explanations don't hold water.



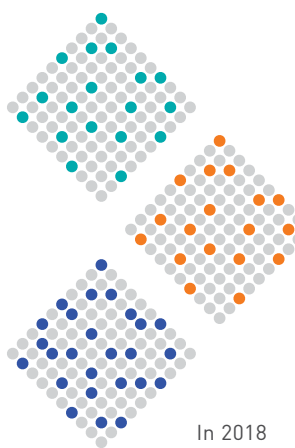
_ NANCY SPECTOR Spector is a professor of pediatrics and vice dean for faculty in the College of Medicine, as well as executive director of the Hedwig van Ameringen Executive Leadership in Academic Medicine (ELAM) program.

authority to implement measurable changes. In striving toward equity, the authors advise that medical professionals tackle the problem with proven methods used to address other problems, including employing leadership accountability, dedicating financial and human resources to gender equity initiatives, and ensuring such efforts are evidence-based, data-driven and transparent in evaluation and reporting.

ALTHOUGH WOMEN make up the majority of full-time faculty and physicians in pediatrics, multiple studies show that gender bias and discrimination against women are pervasive in the field.

Many of the justifications commonly put forward for why this is don't hold water, according to Drexel College of Medicine researchers and colleagues, who looked to data to debunk the myths. They argue that gender equity can be fostered by employing the same basic scientific principles thinkers use to solve other problems in medicine.

Previous efforts to improve gender equity have failed, the authors contend, because initiatives have largely been volunteer-driven at the "grassroots" level, with little support from institutions to succeed. Further, they argue that diversity task forces and similar groups risk "providing an illusion of fairness," and might actually worsen inequities if they cannot gather reliable data to convince those in



In 2018 women made up only: 18% of medical school deans. 18% of medical school chairs. 26% of chairs in pediatrics.

MICROBIOLOGY

_BIG DATA IN THE BIOME

COLONIES OF BACTERIA and viruses naturally coexist throughout the human body and play roles in digestion, metabolism and even fighting off diseases. But for scientists, understanding just how they do it remains a question.

Researchers are hoping to find answers by treating the human biome as a "big data" problem. They're using pattern-recognition algorithms and machine learning to sift through massive amounts of genetic sequencing information that has come available in recent years. Their goal is to identify groupings of microbial communities that occur in concert with each other.

Their findings, published in PLOS ONE, put forth a new method of analyzing the codes found in microbial RNA to reveal how these communities operate.

"There are thousands of species of microbes living in the body, so if you think about all the permutations of groupings that could exist you can imagine what



_GAIL ROSEN
Rosen is a professor in the Department of Electrical and Computer Engineering in the College of Engineering. She heads Drexel's Center for Biological Discovery from Big Data.

a daunting task it is to determine which of them are living in community with each other," says Gail Rosen, who co-authored the paper with Steve Woloszynek, an MD-PhD trainee in the College of Medicine. "Our method puts a pattern-spotting algorithm to work on the task, which saves a tremendous amount of time and eliminates some guesswork."

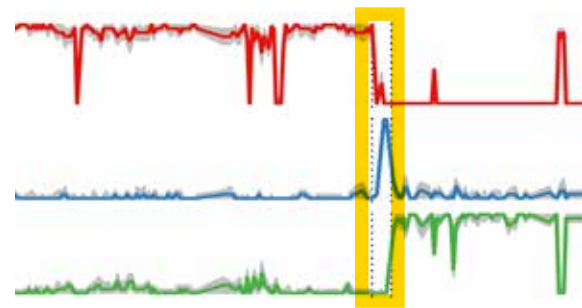
Current methods for studying microbiota, gut bacteria for example, take a sample from an area of the body and then look at the

MEET_METAGENOMICS

Metagenomics is a field of science that applies a computational approach to studying organism interactions and evolution. In this type of research, a scan of a genetic material sample — DNA or RNA — can be interpreted to reveal the organisms that are likely present. The method presented by Rosen's group takes that one step further by analyzing the genetic code to spot recurring patterns, an indication that certain microbes present are found together so frequently that it's not a coincidence. Rosen's team calls this "themetagenomics," because they are looking for recurring themes in microbiomes that are indicators of co-occurring groups of microbes.

genetic material that's present. This process inherently lacks important context, according to the authors.

"Most metagenomics methods just tell you which microbes are abundant, but they don't really tell you much about how each species is supporting other community members," Rosen says. "With our method you get a picture of the configuration of the community — for example, it may have *E. coli* and *B. fragilis* as the most abundant microbes and in pretty equal numbers — which may indicate that they're cross-feeding. Another community may have *B. fragilis* as the most abundant microbe, with many other microbes in equal, but lower, numbers — which could indicate that they are feeding off whatever *B. fragilis* is making, without any cooperation."



GUT_REACTION

The blue line represents the probability of a Salmonella infection (suspected from bad sushi) in a subjects' gut. Researchers observed a drastic change in the microbial composition of the person's gut before and after infection (the yellow bar). This change is signified by the probability of the pre-infection microbiome in red, which declines and is replaced by the probability of the green line.

ORGANIZATION

_TEAMWORK MATTERS

Surgical teams can reduce patient post-surgery stays by paying attention to surgery complexity and surgeon time in the operating room.

ANYONE WHO HAS EVER had surgery knows that the most important question for a patient, after the reassurance of a successful inpatient procedure, is how long it will take before returning home. While the performance of everyone on a surgical team is important, some roles play a greater part in how long a patient may need to remain at a hospital post-surgery.

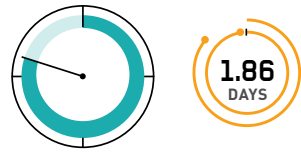
New research forthcoming in the *Journal of Applied Psychology* looked at how the interaction between the core surgical team member, or the surgeon, and the non-core surgical team members, such as the circulator nurse, scrub tech and anesthesiologist, can affect team performance.

"Our findings could help hospitals optimize staffing in operating rooms for a more successful surgery and decrease the postoperative length of hospital stay," says study co-author Lauren D'Innocenzo, an associate professor of organizational behavior in the LeBow College of Business.

The researchers analyzed archival data from 7,070 surgeries at a large U.S. community hospital. From this data the researchers were able to compute how many times an individual surgeon had worked with non-core members on similar types of surgery. They then examined the time between surgery completion and patient discharge.

They found that a surgeon's prior experience with the rest of the surgical team

The relationship between surgeon experience with non-core members and team performance was weaker when the surgeon spent less time in the operating room.



If the surgeon is present for 80 percent of all intermediate-level complexity procedures (e.g., gastric resections), then the patient would be expected to stay in the hospital for 1.86 days.



If the surgeon is present for only 60 percent of the time, the expected patient hospital stay jumps to 2.88 days.

played a vital role in the team's performance, as did the surgeon's physical presence in the operating room. Specifically, if the surgeon had performed the same type of surgery with the same team members before, patient stays were shorter.

However, the complexity of the surgery was a critical factor in this relationship. Findings indicated that the relationship between surgeon experience with non-core members and team performance was weakened when the surgery was more complex and when the surgeon spent less time in the operating room.

_THERAPY VIA SCREEN

Is virtual reality the next big thing in art therapy?

THE EVER-EXPANDING field of virtual reality has been used in health care settings like physical rehabilitation and made its way into therapy settings to reduce phobias and delusions. Could VR also be used as an expressive tool in art therapy?

To try to answer this question, researchers from Drexel's College of Nursing and Health Professions in the Creative Arts Therapies Department conducted one of the first studies of its kind to systematically examine how art therapy can be integrated into virtual reality-based expression to enhance patient care.

"Art therapy is founded on the idea that creative expression with an art therapist facilitates communication and problem solving, reduces inhibition, alleviates depressive symptoms and promotes personal development," says lead author of the study Girija Kaimal, an associate professor in the College of Nursing and Health Professions.

In the study, five men and 12 women engaged in free-form, immersive VR art-making for about 20 to 25 minutes, and were then invited to discuss their experience during a therapeutic session. The results were published in the *Journal of Art Therapy Association* in September 2019.

"This study provides the groundwork for VR as an art therapy tool, especially as the technology becomes more sophisticated," Kaimal says.

_THE TECH

The researchers conducted their art therapy sessions using the HTC VIVE VR headset, remote control devices, and a Leap Motion controller running on a personal computer. The software they used was Tilt Brush by Google, to create 3D images in VR; Kodon, for virtual sculpting; and Nature Treks, to create an immersive 3D environment for relaxation.

_THE ARTWORK

As part of the study, participants created 3D and still artwork using virtual reality. After the session, participants were invited to save their artwork and talk about their experience with the art therapist.

_THE EXPERIENCE

The researchers found that creative expression in VR reduced inhibitions, activated full-body movements and enhanced mood and creative play exploration among participants. It also challenged the participants' perceptions of physical reality, traditional art making and art media. Some were, however, disappointed by the lack of tangible, physical engagement with the medium and for a few, the experience was disorienting, Kaimal says.

_# OF PARTICIPANTS

5 men / 12 women

_SESSION LENGTH

20-25 minutes



H I V
THE NEXT GENERATION

WHAT'S NEXT FOR HIV RESEARCH? WHILE THE DREAM OF A CURE REMAINS, SCIENTISTS ARE ALSO STUDYING WAYS TO ADDRESS THE HEALTH IMPACTS ENDURED BY THOSE LIVING LONGER LIVES WITH HIV.

_by Elisa Ludwig

ANTIRETROVIRAL MEDICATIONS transformed the AIDS epidemic from an urgent crisis to a manageable chronic disease, and with that, research has shifted to the next phase of the disease's evolution. Scientists are now deeply engaged with a new set of questions: How can HIV patients improve the quality of their lives? What aging conditions or diseases might they be more susceptible to as a result of sustained infection? Are there better treatments with fewer side effects or greater effectiveness? How long before scientists discover a vaccine that will conquer this health threat once and for all?

At Drexel, five scientists in the College of Medicine are on the case searching for answers that will make life better for those living with the virus.



CLOSING THE DOOR ON HIV

PROFESSOR OF BIOCHEMISTRY and Molecular Biology Irwin Chaiken wants to stop HIV before it can take hold in the body. As a protein scientist, he focuses on the entry mechanism of the virus into cells. "I realized that if we could reveal the fundamental properties of the virus cell entry protein machine, we might figure out a way to stop infection itself," he says.

That has meant defining the HIV envelope surface protein, known as Env. When it interacts with cells, the Env changes shape so that it anchors on both the virus and the cell. Chaiken and a multi-institutional cohort of collaborators, funded by the National Institutes of Health, have been seeking ways to hijack entry interactions, including compounds that change the Env's shape and irreversibly inactivate the protein complex before cell encounter.

As the findings have evolved, Chaiken says, so too have the objectives.

"The research field has certainly changed over time," he says. "Initially, we were more focused on blockers to stop the infection. But now there is a very strong push to find a cure and eradicate both the virus and infected cells altogether. Compounds we have found have the potential to be developed for eradication, but we still have a long way to go."

Ultimately, Chaiken would like to see the translation of mechanistic findings into commercialization projects. To that end, he has formed a team with seed funding from the Coulter-Drexel Translational Research Partnership, a tech commercialization program that supports academic research ideas that have potential to fulfill unmet or underserved clinical needs. However, Chaiken doesn't anticipate having a working compound for at least five to 10 years.

"People afflicted with HIV-1/AIDS want a cure, and there is currently no frontline therapy for HIV that uses the same target we're going after," he says. "If we developed such a compound, it could potentially be used in combination with existing therapies. I don't think we should shy away from finding additional therapeutics, because people can still become resistant to the ones that are out there."

The developments have been exciting and profound. At 79, Chaiken plans to continue exploring the fundamental questions he's been posing throughout his career.

"The work we've already done could ultimately tell us how to defeat HIV, and that is a very rewarding prospect," he says.



_IRWIN CHAIKEN
Chaiken is a professor in the Department of Biochemistry and Molecular Biology.



FOR PETER GASKILL, HIV research will always be in some way personal. The assistant professor in the Department of Pharmacology & Physiology funneled his passion for science into this particular subject matter in large part because his own mother tested positive for HIV infection in the heart of the AIDS panic of the early '90s.

"My parents found out because of a blood test anomaly, which was reported to them through a letter from their insurance company," he says. "I was a teenager at the time. There was no Internet and I didn't know anything about HIV or AIDS."

His mother's illness had a profound impact on Gaskill's life in many ways, and her death, just before he graduated from college, drove home the realization that far too little was understood about HIV.

"She was taking about 40 different medications, including the earliest antiretrovirals, and the medications were making her quality of life worse," Gaskill says. "When she went into septic shock, the doctors were telling us in so many words that there was nothing anyone could do. I remember thinking I will never not know again."

As a researcher, Gaskill homed in on the neuroHIV field, an area of science that explores the pathology underlying the cognitive and behavioral impact of HIV infection in the brain. The range of conditions caused by HIV damage to the central and peripheral nervous systems can include vacuolar myelopathy, sensory neuropathy, anxiety and depression, and dementia. "I was interested in the physical changes that cause neurocognitive issues. In today's epidemic, where many people are on antiretroviral therapy, we've found that a lot of the physical changes we've seen don't always correlate with the cognitive or behavioral categories we've created. It makes it challenging to design targeted therapies, because it is hard to solve a problem if you don't know the underlying cause."

The Gaskill Lab is currently investigating the impact of drug abuse on HIV-associated neurocognitive disorders, particularly as it relates to dopamine-mediated changes in macrophages — cells that play a central role in HIV neuropathogenesis.

A large number of people with HIV experience substance use disorders, which have been linked to acquiring the virus, but which may also change the course of the infection itself. Gaskill and his collaborators are looking at the mechanisms inside the human cell after dopamine or HIV binds to its surface. This research also applies to legal therapeutics such as antidepressants and their relationship with neuroimmune function.

"People are living longer with HIV, but that longevity creates a series of new problems," Gaskill says. "People are depressed. They have diabetes, gastrointestinal issues, cardiovascular problems and neurocognitive effects as well. The treatments themselves can cause these issues, and then there are comorbid factors like drug abuse, which also contribute to problems. If we want to treat people who use drugs of abuse, or people who have Alzheimer's or Parkinson's disease, we have to come up with better therapeutics to do so. There's a lot more we still need to know."



_ ELIAS EL HADDAD
El Haddad is a professor of medicine in the Division of Infectious Diseases & HIV Medicine.

MULTIPRONGED ATTACK

Elias El Haddad, a professor of medicine in the Division of Infectious Diseases & HIV Medicine, first witnessed people infected with HIV when he was a graduate student conducting research in Lebanon in the 1980s. Before the advent of AZT, the outlook was grim.

"People knew they were dying — a big community had come to Lebanon from sub-Saharan Africa, where there was no treatment for them," El Haddad says. "It was worse than cancer in how fast it progressed. Today, the picture is so different, but we still need the ultimate cure, which would be a vaccine."

As a researcher, El Haddad takes a cross-disciplinary approach, and his HIV work centers on three distinct projects: vaccine development, cure discovery and basic research about the virus' mechanisms.

"We need to better understand infection, how HIV acts in the body and how the host responds to it," he says. "I have been working in HIV since 2000, and my research has changed in that time, from looking at the pathogenesis of the infection to trying to understand the mechanisms of immune response."

With the help of HIV-infected individuals, specifically the so-called "elite controllers," who have the ability to control virus replication without the need for antiretroviral therapy, El Haddad and his collaborators have been able to study the mechanisms of the host immune response to the virus as it progresses in the body.

In identifying a biomarker for central memory T cells and memory B cells, he has uncovered how these patients might naturally keep the virus at bay, with potential implications for immunotherapy treatment targets.

El Haddad's vaccine work has advanced significantly in recent years with a finding published in *Nature Medicine*, where he and his colleagues described a new subset of T cells, called follicular helper T cells, that is important for humoral immunity and is defective in HIV-infected individuals. More recently, in a study published in *Nature Communications*, he demonstrated a new molecule called ADA that could be harnessed to target follicular helper T cells and might be used as a target for a novel vaccine.

"There are still many people who are at risk for getting the virus, and a vaccine could prevent this," he says. "At the same time, a vaccine and immunotherapy are not necessarily mutually exclusive. We might be able to use both together."

El Haddad's lab is currently working to develop and test an adjuvant to see whether it can induce or alter the immune response to HIV infection. His latest results will be published in upcoming papers. For now, he finds that emerging discoveries and the commitment of patients keep him optimistic about the future of the field.

"The people who volunteer for research have made our work possible," he says. "That motivates me to continue and stay hopeful that this work will eventually have a significant impact."



_ PETER GASKILL
Gaskill is an assistant professor in the Department of Pharmacology & Physiology.

MICHAEL NONNEMACHER can remember when, as a teenage science geek, he would tell his friends that someday he'd find a cure for AIDS.

"Back in the '80s and '90s, we knew so little about the disease, and I was naive about what it really meant to be able to accomplish such a thing," says the associate professor in the Department of Microbiology & Immunology.

As a graduate student at Penn State University, Nonnemacher started working with Brian Wigdahl, examining how genetic variations of HIV might impact proteins important for the virus' replication in immune cells. When Wigdahl was recruited to Drexel, where he now directs Drexel's Institute for Molecular Medicine and Infectious Disease, Nonnemacher joined him.

He currently researches diagnostics for neurocognitive impairment, which occurs in about 50 percent of HIV patients. "We think the protein called Tat plays a large role in driving the replication of the virus, and causing neurotoxicity and the pathogenesis seen in the central nervous system," he says.

Through gene sequencing and biostatistics, Nonnemacher and his fellow College of Medicine colleagues Sandhya Kortagere and Will Dampier can study associated amino acid changes in patients, which they hope will lead to a genetic diagnostic test for neurocognitive impairment.

On another project, with Wigdahl and teams of researchers at Temple University and Case Western Reserve, Nonnemacher is looking at a potential therapeutic solution for HIV that uses leading-edge CRISPR gene-editing technology, developed initially for cancer treatment.

"We are developing guide RNAs with the potential to be broad spectrum, to account for viral quasi-species within and between patients infected with subtype B virus, the most commonly found in the Americas and Europe," he says. "If we can edit the HIV genome, cutting it out completely, making the promoter defective, and/or eliminating the proteins necessary for replication, we think this approach can be used as a therapeutic."

While human trials are still a long way away, the application of this technology for HIV could be very promising. Nonnemacher tells his students that they should look outside their own narrow window of research to the larger scientific community, as sometimes the answers might lie beyond their immediate scope. After all, he says, before 2013, gene editing wasn't something he'd ever imagined using. Once he did, however, a new direction for his research, along with new possibilities for actually finding a treatment, suddenly emerged.

"To be where I am now, to be looking at therapeutics and diagnostics, is very exciting and it shows the evolution, what we've learned and just how far we've all come," he says. "Now I'm hopeful that we just might see the light at the end of the tunnel."



_ MICHAEL NONNEMACHER
Nonnemacher is an associate professor in the Department of Microbiology & Immunology.



_ VANESSA PIRRONE
Pirrone is an associate professor in the Department of Microbiology & Immunology.

IMPROVING LIFE WITH HIV

Vanessa Pirrone '09 was a high school science teacher when she first studied HIV with her students — a formative moment in her decision to go back to school and pursue a research career.

"We read a book about the discovery of the HIV virus in the '80s, and I found it fascinating — namely, the idea of identifying an infectious disease that is afflicting so many people," says the associate professor in the Department of Microbiology & Immunology. "I wanted to know how you identify a disease like that, and how you delve deeper to understand the mechanisms at work."

In her collaborative research — funded by NIH, Temple University's Comprehensive HIV Program and the Sidney Kimmel Cancer Center — Pirrone works across a number of different areas, largely focusing on what it means to live with HIV as the first generation grows older with it. With Department of Microbiology & Immunology Chair Brian Wigdahl, she studies a local cohort of patients every six months to see how the virus has progressed. The patient cohort includes not just individuals who are aging with HIV, but some older patients who have been newly infected.

"We collect patient blood samples and ask them questions to delve into their clinical and demographic history," she says. "This information helps us springboard other research questions. The studies I'm most interested in have to do with HIV and aging. We're finding out that the aging process for HIV patients is not the same, and we want to understand why."

Some of the conditions HIV patients are developing include osteoporosis and mild, progressive dementia 10 years earlier than the population at large. Forty percent of HIV patients develop cancer, not just AIDS-defining cancers like Kaposi sarcoma, but liver, oral and colon cancer. Pirrone is studying the connections between the diseases, working with both colon and anal cancer patients.

The question Pirrone is raising is whether HIV synergistically accelerates immune system response and thereby accelerates the aging process. She is now in the process of taking her research from the bedside to the molecular and cellular biology bench, studying the mechanisms that emerge. The goal is to develop therapeutics, screening paradigms and regimens for existing treatments for aging patients.

She's grateful to be working in a time when she can build on the advances that came before her.

"Our patients know that we might not be able to change anything in their lifetime, but we have the potential to help future generations," she says. "Even if we can't cure patients, we can help them understand their risks and the biomarkers to watch for these diseases. Ten years later — to say I've been able to contribute to the body of research about HIV is an amazing thing."

This article previously appeared in spring/summer 2019 edition of the Drexel University College of Medicine Alumni Magazine.

CULINARY ARTS

NOTHING WASTED

The Drexel Food Lab partnered with a popular restaurant on a “whole food” menu experiment that was part industry partnership, part sustainability experiment, part virtual co-op and 100 percent delicious.

IN A PARTNERSHIP funded by the private, Plymouth Meeting-based The Claneil Foundation, the Terrain Café in Glen Mills, Pennsylvania, teamed with Drexel Food Lab faculty and students to dream up dishes for the café’s new sustainability-focused weekend menu.

The otherwise routine task of concocting delicious dishes was given a challenging twist: Each three-course menu revolved around a single produce item — including tomato, corn and melon — with an upcycle goal of using the “whole plant,” including parts not typically incorporated into a meal.

Think tomato peel powder, or fried corn silks, or pickled watermelon rinds.

“[As chefs] we pull from our past a lot. We create boxes and boundaries for ourselves. When you work with students, they have no boundaries, no boxes.”

“The No. 1 way to reduce food waste is source reduction and full product utilization,” says Jonathan Deutsch, founder and director of Food Lab. The lab, housed inside the College of Nursing and Health Professions, promotes sustainability, health and food access through the design of new



JONATHAN DEUTSCH Deutsch is a professor in the Department of Food and Hospitality Management in the College of Nursing and Health Professions and director of the Drexel Food Lab.

food products and innovative culinary methods.

Terrain Café Executive Chef Brian Lofink '03 met with Food Lab students over Zoom to conjure dishes for the month-long run of a sustainable weekend menu in September 2020. He then worked with Deutsch to sketch out recipes and finalize.

“I always say the best chef in the world can’t be more creative than a bunch of culinary students,” Deutsch says.

“We pull from our past a lot,” Lofink agrees. “We create boxes and boundaries for ourselves. When you work with students, they have no boundaries, no boxes.”

TRENDY_SPREAD

Executive Chef Brian Lofink '03 and fifth-year co-op student Anna Wilson plate a panzanella salad in the kitchen of Terrain’s garden café. For safety during the pandemic, the team recipe development work was done virtually, and the restaurant operated at reduced capacity.



AUTISM

DISCRIMINATION

SOCIAL JUSTICE

MANAGEMENT

PRIVACY

_SOCIAL ON THE SPECTRUM



ELIZABETH MCGHEE HASSRICK is an assistant professor with the Life Course Outcomes Research Program at the A.J. Drexel Autism Institute.

to help young adults on the spectrum build networks and access social resources needed to support positive outcomes in adulthood.

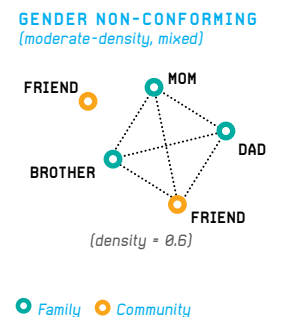
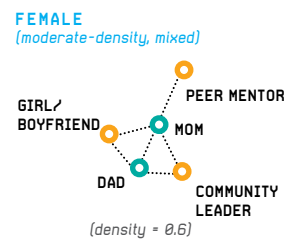
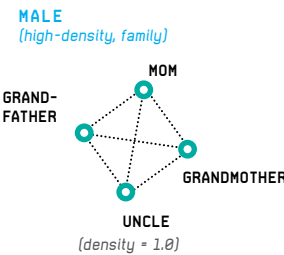
"Interpersonal relationships and the resources and support embedded in the social networks of autistic young adults could impact key adult outcomes, including quality of life, mental health, employment and independence," says McGhee Hassrick.

WHILE SOCIAL isolation is a core challenge associated with autism, researchers from the A.J. Drexel Autism Institute have laid the groundwork to show how interpersonal relationships, and the resources they provide, could impact autistic youth's adult outcomes.

"Many autistic young adults are disconnected from people, communities and organizations that could provide them with valuable social resources to support their transition to adulthood," says Elizabeth McGhee Hassrick, lead author of the study.

Researchers asked 17 adults on the spectrum who were undergoing post-high school transition (ages 19 to 27) to complete an online survey about their social connections and the different types of support they gain from those connections. They then also asked parents of three of the young adults to identify the social connections they rely on to help their children transition successfully, and mapped the connections to see how interrelated, or not, the networks were.

This project produced new and useful ways of collecting social network data from young autistic adults that will shed light on how



NETWORK_MAPPING The researchers used social network analysis to map the young adult subjects' social connections, as perceived by both the young adults and their parents.

_NATURAL HAIR? DON'T CARE

A law professor has helped draft a federal bill that will prevent employers from discriminating against Black employees who wear natural ethnic hair styles.

UNDER FEDERAL LAW, employers can't discriminate against Black workers who wear afros, but they can discriminate against employees who don't wear any other natural ethnic hairstyles.

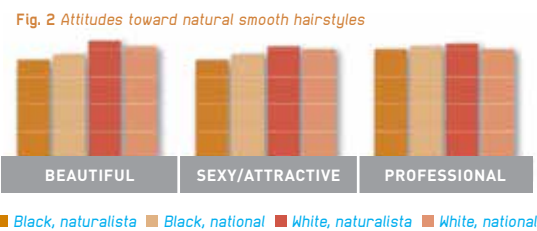
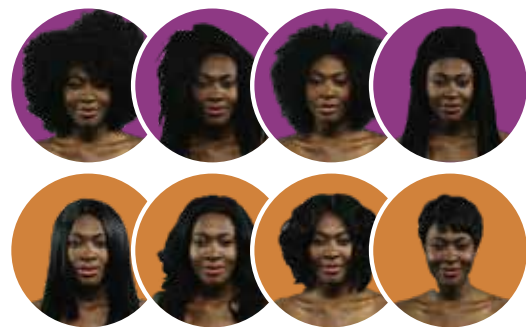
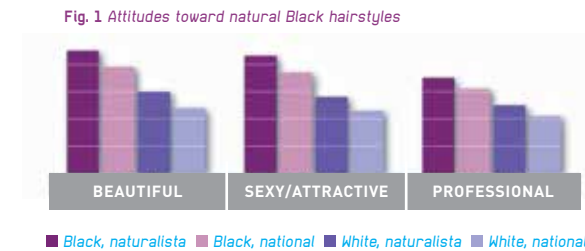
"If you twist, loc or braid that afro and are discriminated on those grounds, then magically you're no longer protected under federal law," explains Kline School of Law Professor Wendy Greene.

This is because federal courts have characterized these other hairstyles often worn by African descendants as "mutable, cultural characteristics" and beyond the scope of Title VII of the 1964 Civil Rights Act.

Greene calls this a "hair-splitting" legal distinction. To cure it, she has worked with legislators to draft the Create a Respectful and Open World for Natural Hair Act, known as the CROWN Act.

The bill was introduced in the U.S. House of Representatives and the U.S. Senate in 2019 and 2020 respectively, and passed in the House last year. Similar legislation was also passed in seven states and in several municipalities.

Black women experience greater levels of pressure to wear their hair straightened and experience higher levels of anxiety about wearing



SPLITTING_HAIRS A survey of Black and white women published by Perception Institute in 2017 found that white women's attitudes toward natural Black hairstyles were noticeably less positive than Black women's attitudes (figure 1). Attitudes toward smooth hair were more positive among respondents of both races (figure 2), indicating smooth hairstyles have more normative acceptance.

their hair naturally than white women because they are fearful of losing employment opportunities and/or being subjected to workplace harassment, according to a 2016 survey by Perception Institute.

"This bill helps chip away at a centuries-old, race-based hierarchy that

privileges aesthetic norms associated with whiteness, such as straight-hair preferences for women, and the negative associations with characteristics often associated with Blackness like our naturally curly hair texture and hairstyles flowing from it," Green says.

_ONLINE Learn more about Greene's movement to combat race-based natural hair discrimination at freethehair.com.

_WHEN NIKE TAKES THE KNEE

As the nation's political divide continues to widen, companies have stepped away from neutral positions and become increasingly outspoken. What does this mean for marketing?

WHAT DOES corporate political activism mean for the future of marketing and how companies appeal to consumers?

It's a benefit, argues Daniel Korschun, an associate professor of marketing in the LeBow College of Business.



DANIEL KORCHUN is an associate professor of marketing in the LeBow College of Business.

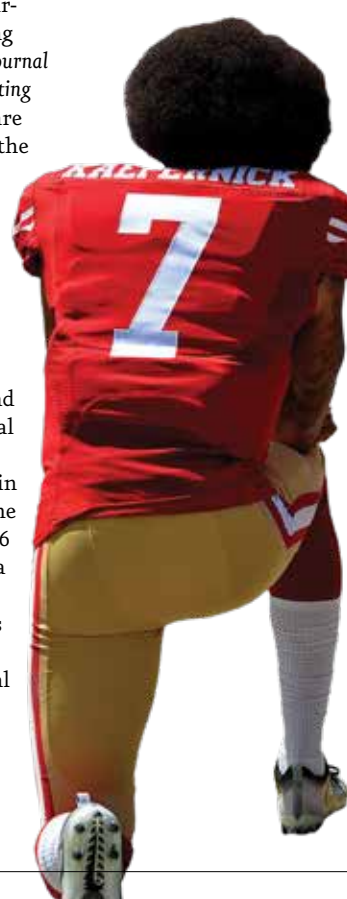
"It can really drive loyalty on the part of consumers," says Korschun, who explored the role of marketing in understanding political activity in a Journal of Public Policy and Marketing editorial. "Consumers are purchasing more than the product, they're purchasing an affirmation of who they are and what they stand for."

He notes that Nike was one of the first companies to highlight racial injustice when the company aired an ad during the 2018 National Football League season opener narrated by Colin Kaepernick, who became a national figure in 2016 when he chose to take a knee while playing for the San Francisco 49ers during the national anthem to protest racial injustice.

"For the current generation of market-

ing managers, Nike really defined how a controversial socio-political issue can be used to differentiate the brand," says Korschun. "Some customers protested, but Nike's overall sales increased shortly after the campaign launched." But Korschun warns there is the potential for marketing to fuel political extremism.

"Businesses have the potential to represent the interests of diverse constituencies who are sometimes voiceless," he says. "So it's critical that we make sure companies don't end up widening existing divisions or using politics as a means to increase market power."



_UNIFORM CUES

DO SALES TEAM uniforms create uniformity in rates of customer satisfaction? According to research from Drexel and the University of British Columbia, customers feel like they are getting the best customer service when sales associates share an air of uniformity, by dressing and acting alike.

However, this isn't the case when the products being sold require some level of creativity, according to research led by Chen Wang, associate professor of marketing in Drexel's LeBow College of Business.

Using four different studies, researchers looked at how appearance entitativity cues and behavior entitativity cues can impact a sales team's perceived service quality, which in turn influences customer satisfaction.

According to their analysis, retailers should consider four key factors to enhance customer satisfaction:

- 01 / ask sales teams to dress alike.
02 / train sales team members to act with the team in mind.
03 / do not encourage entitativity for industries involving creativity.
04 / ensure that entitativity cues are consistent.

"If one of them is off and one member of the team doesn't dress like the others or isn't coordinated then any positive effect can be undermined," says Wang.

_WHEN DATA GETS LOOSE

Researchers have proposed a new methodology to shuffle survey data so individuals aren't identifiable even if datasets accidentally go public.

ORGANIZATIONS are constantly collecting confidential consumer data, but how long does it stay private? Although datasets are supposed to be anonymized or encrypted for confidentiality, proprietary information has a way of getting out. In fact, Verizon confirmed 3,950 data breaches worldwide in its 2020 annual "Data Breach Investigations Report," with 30 percent of those executed by internal actors such as employees.



MATTHEW SCHNEIDER is an assistant professor in the Decision Sciences and Management Information Systems department for the LeBow College of Business.

"Assume that all data will eventually get out and should be transformed prior to sharing anywhere within the organization."

- Matthew Schneider

"Encryption definitely helps, but it does not prevent a data breach," says Matthew Schneider, an assistant professor in the LeBow College of Business. "It's similar to safeguarding your email password; an internal actor with access to the encryption key or real data could easily cause a data breach."

Privacy is also a problem for local governments and other entities that conduct confidential surveys of their constituents that they are legally required to share with the public. It's relatively simple for an unethical actor to use public datasets to identify a particular respondent and figure out their revealing private responses. To solve this, Schneider and his research partner Dawn Iacobucci of Vanderbilt University proposed a new methodology that permanently alters survey datasets to protect consumers' privacy when the data is shared, whether intentionally or through a breach. Their methodology, published in the Journal of Marketing Analytics, was built upon a technique found in genomic sequencing applications that was able to disguise the identity of survey respondents and their sensitive responses while maintaining the accuracy of insights within 5 percent. "Our method would essentially 'shuffle' the demographic data in a survey dataset," says Schneider. "But, unlike previous methods, ours only shuffles data when it maintains the correlations between important variables that are essential to analysts. The protected data is generated on a consumer level and still valuable to the end user. This can also be done for employee surveys. If this dataset got out, then only the organization's insights would be known."

CIVIL RIGHTS

JUVENILE JUSTICE

POLITICS

_A LICENSE TO BE TRANS

Simply reducing barriers to changing one's gender state-issued ID could have dramatic mental health benefits for transgender adults.

MOST PEOPLE take for granted that their passport, driver's license or birth certificate accurately represents who they are to the world. But for transgender individuals, government-issued identification may potentially expose them to harassment, denial of service or violence.

9 / 10

transgender adults do not have their preferred name and gender marker on all of their identification documents.

45%

did not have their preferred name and gender designation on any identification documents.

Those who had had their preferred name and gender on all documents were:

32%

less likely to be classified as seriously psychologically distressed.

22%

less likely to have seriously considered suicide in the past year.

Source: 2015 U.S. Transgender Survey conducted by the National Center for Transgender Equality.

Schein co-authored a study, published in March 2020 in The Lancet Public Health, which posits that gender-affirming identification documents may improve mental health among transgender adults.

The study used data from 22,286 adults who participated in the 2015 U.S. Transgender Survey conducted by the National Center for Transgender Equality, and who were living in a gender different from the one assigned at birth. Nine out of 10 transgender adults in the dataset did not have their preferred name and gender marker on all identification documents.

Those with their preferred name and gender on all documents were 32 percent less likely to be classified as seriously psychologically distressed, compared to those without. They were also 22 percent less likely to

have seriously considered suicide in the past year and 25 percent less likely to have made a suicide plan in the last year.

The work is the first study in the United States to look at the connection between identification documents and improvements in multiple measures of mental health, including suicidal thoughts. Previous studies have looked only into how medical gender affirmation procedures, such as hormones and surgery, impact mental health.

_SCHOOL SUSPENSION

Researchers are working on improving education outcomes for juveniles detained in the justice system, who often fall behind academically or fail to receive credit for their courses while behind bars.



_NAOMI GOLDSTEIN Goldstein is a professor of psychology in the Department of Psychology in the College of Arts & Sciences and head of the Juvenile Justice Research and Reform Lab.



BACK_TO_SCHOOL

Goldstein and her Juvenile Justice Research and Reform Lab recently convened a meeting to build what she calls, a "prison-to-school pipeline." It's a structured process to reverse the school-to-prison pipeline by successfully reintegrating youth into schools following juvenile justice confinement and supporting these youth on their paths toward graduation. Leaders of Philadelphia's juvenile justice and child-serving agencies, legal advocates, researchers and individuals with lived juvenile justice experience came together for three days to develop and begin enacting policy and practice changes to promote youth offenders' successful re-enrollment and engagement in school following release.

unwarranted setback that often results in drop out." The authors, who included researchers from the Juvenile Law Center, Education Law Center, Southern Poverty Law Center and Drexel, conducted a national survey of 208 professionals from 135 counties across 34 states and the District of Columbia. Just 9 percent of respondents said youth always earn credit for all their coursework in detention facilities, which are short-term centers

27%

of survey respondents said that classes in juvenile detention facilities are not aligned with school or district standards.

When young offenders are sent to juvenile justice facilities, their education is supposed to continue behind bars. Yet they frequently don't receive credit for the work they complete while there, according to a report co-authored by Psychology Professor Naomi Goldstein. The report, "Credit Overdue: How States Can Mitigate Academic Credit Transfer Problems for Youth in the Juvenile Justice System," is the first of its kind to analyze the problem from a national perspective, including the consequences youth experience. It also examines the legislative solutions necessary to ensure youth receive the academic credits they are due.

"Many youth spend months or years taking classes while locked up in juvenile justice facilities, and they appropriately expect their hard work to pay off and contribute to a high school degree," Goldstein says. "Despite legal requirements that these academic credits should transfer, youth often lose months or years of credits. When they are discharged...many find they have to start over, an

_DO SANCTIONS WORK?

Researchers were curious to know how impactful sanctions had been in recent history, but no such comprehensive catalogue existed. So they created it.

IMPOSING SANCTIONS is among the most common ways governments attempt to influence one another's policies. Yet until recently there was no comprehensive accounting of their nature, use and international consequences.

To fill this void, School of Economics PhD candidate Aleksandra Kirilakha together with economics professors Constantinos Syropoulos and Yoto Yotov of the LeBow College of Business and Gabriel Felbermayr, president of the Kiel Institute for the World Economy, and professor Erdal Yalcin of Konstanz University, created the Global Sanctions Data Base (GSDB).

It has become one of the most prominent tools for research in this area, accessed by more than 400 researchers worldwide to date.

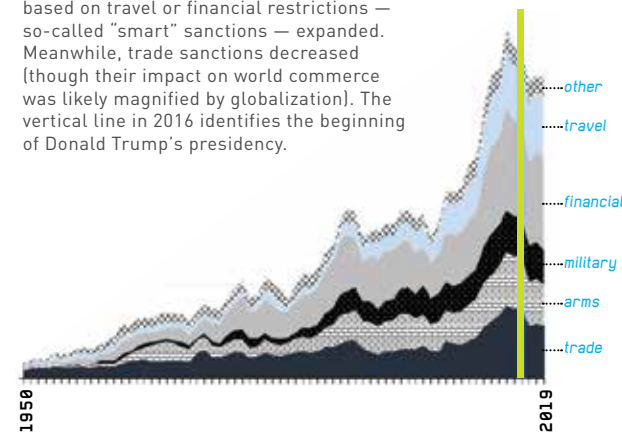
"Economic sanctions are policy actions by states to influence other states to take particular actions that will fulfill some sort of objective, usually related to human rights, terrorist activities or termination of wars," Syropoulos says. "They differ from other kinds of policies in that they aim to alter a target's policy actions."

Among other things, they found that more than 190 countries have imposed sanctions, and that the rate of success has been 30 to 50 percent.

"Sanctions play a very important role for international trade flows," Yotov says. "If you do not control properly for the presence of sanctions and their impact, predictions about the effects of other trade policies may be significantly biased."

_RISE OF "SMART" SANCTIONS

The Global Sanctions Data Base shows that between 1950 and 2019, the use of sanctions based on travel or financial restrictions — so-called "smart" sanctions — expanded. Meanwhile, trade sanctions decreased (though their impact on world commerce was likely magnified by globalization). The vertical line in 2016 identifies the beginning of Donald Trump's presidency.



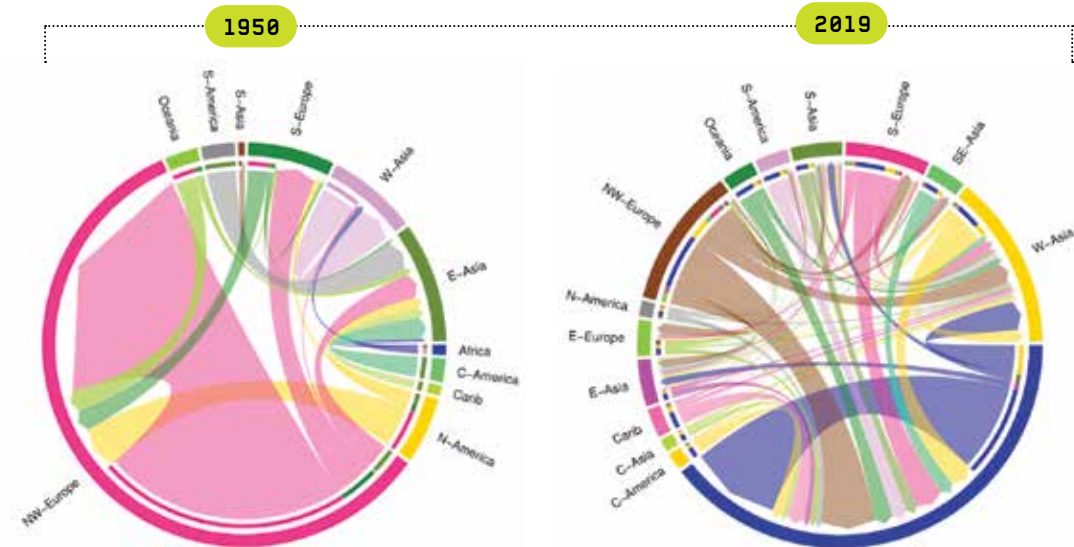
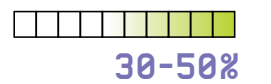
COMPILING THE DATA

Over a six-year period, the team pored through thousands of government documents and media reports, organizing a database that tracks the use and effectiveness of 1,101 instances of sanctions from 1950 to 2019.

190+

Number of countries to have imposed sanctions between 1950-2019

RATE OF SUCCESS:



The use and variety of sanctions overall has exploded over the past 70 years. In 2019, the United States and Europe were the most active instigators of sanctions, followed by North African nations and Canada. In contrast, Western Asian and African countries have been the most frequent targets.

The direction of the arrows identifies the sender and target regions, and each arrow's thickness indicates the number of imposed sanctions.

SANCTIONS TARGETS AROUND THE WORLD

_CONTACT

The Global Sanctions Data Base is freely available by emailing a request to gsdb@drexel.edu.

_ABOUT DREXEL



LIFE SCIENCES_AT_UCITY

A \$1 billion development called uCity Square is nearing completion on Drexel's University City campus. The site will be home to a new academic tower for Drexel's medical and life sciences disciplines, as well as a new public school building paid for with public-private funds raised by Drexel.

FOUNDED IN 1891 in Philadelphia, Drexel is a comprehensive urban university of more than 24,000 students with one of the country's most established co-operative education programs.

Drexel is a leader in experiential, technology-infused education and cross-disciplinary research. The University's recognized excellence in translational research is supported by the Coulter Foundation through the Coulter-Drexel Translational Research Partnership Program and by \$134.8 million in sponsored research awards last year.

Drexel enrolls students in on-campus and online programs leading to associate's, bachelor's, master's, doctoral and professional degrees (including MDs and JDs) in 18 colleges and schools. Drexel also has some of the richest specimen and artifact collections in the world through the Academy of Natural Sciences of Drexel University, America's oldest natural history museum. In partnership with Tower Health,

Drexel medical students train at St. Christopher's Hospital for Children and at a soon-to-open facility in West Reading, Pennsylvania.

Drexel advances its culture of innovation by encouraging multidisciplinary collaboration, technology commercialization and entrepreneurship — an approach exemplified by the ExCITe Center, the interdisciplinary A.J. Drexel Institutes, Drexel Applied Innovation, the Innovation Center @ 3401 Market Street, the Close School of Entrepreneurship and the Baiada Institute for Entrepreneurship.

Drexel operates out of its 123-acre University City Campus in West Philadelphia and at four additional locations: 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 Online.

_ONLINE
Learn more about Drexel University at drexel.edu.

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Drexel provides visionary engineers with the resources and expertise to change the world around them. Inspired by his mother-in-law's breast cancer diagnosis, Drexel alum Mihir Shah collaborated with University professors and co-op students to develop the iBreastExam. This handheld device is able to be used outside of traditional hospital settings to quickly detect cancerous tumors and lesions through a painless and radiation-free scan. Recognizing the global need for increased access to early detection tools within underserved populations, this transformative technology is now saving lives in more than 10 countries.



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