

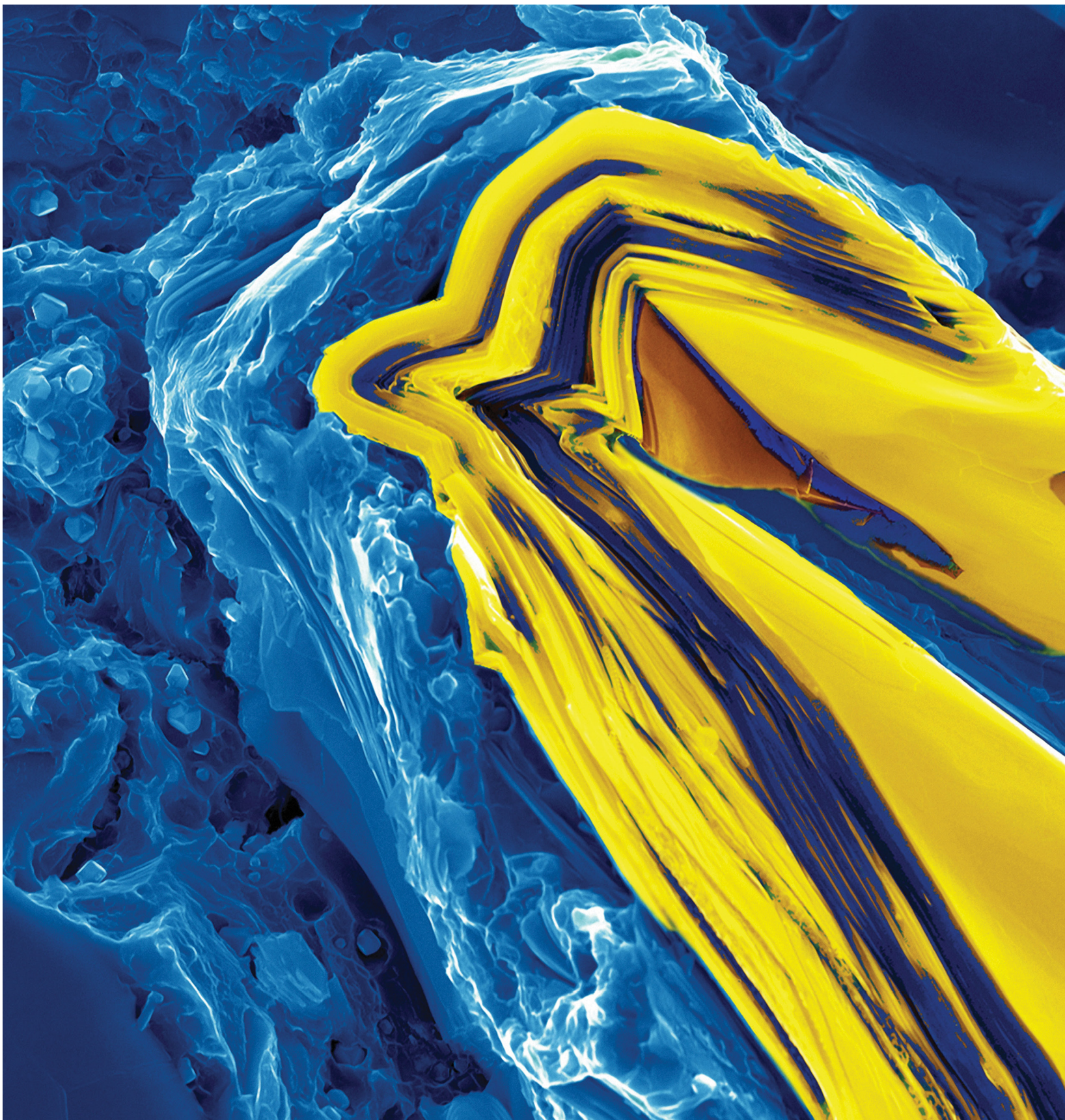


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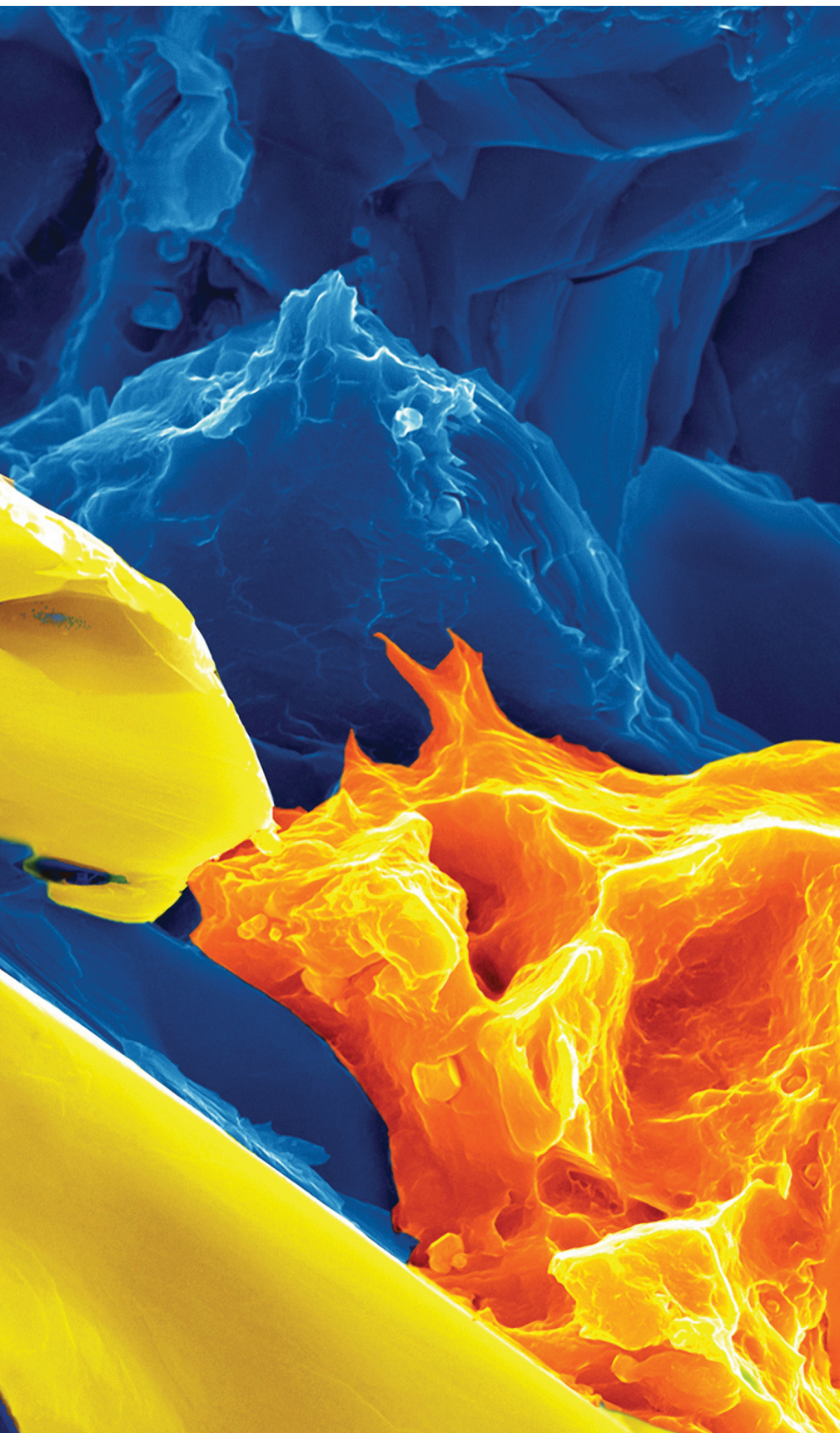
## FROZEN IN FLIGHT

The Peale Butterfly and Moth Collection offers a window into the vast collections at the Academy of Natural Sciences of Drexel University.









## \_THE INTERSECTION OF SCIENCE AND ART

*The images that follow were created by researchers and students working in **Drexel's Centralized Research Facilities**, using electron microscopes that can achieve magnifications that would scale a grain of sand up to the size of a football stadium. The images, taken at the nano-scale, do not actually have any color; the colorization here was added by Drexel researchers for dramatic effect, creating images that live at the peculiar intersection of science and art.*



**BABAK\_ANASORI**

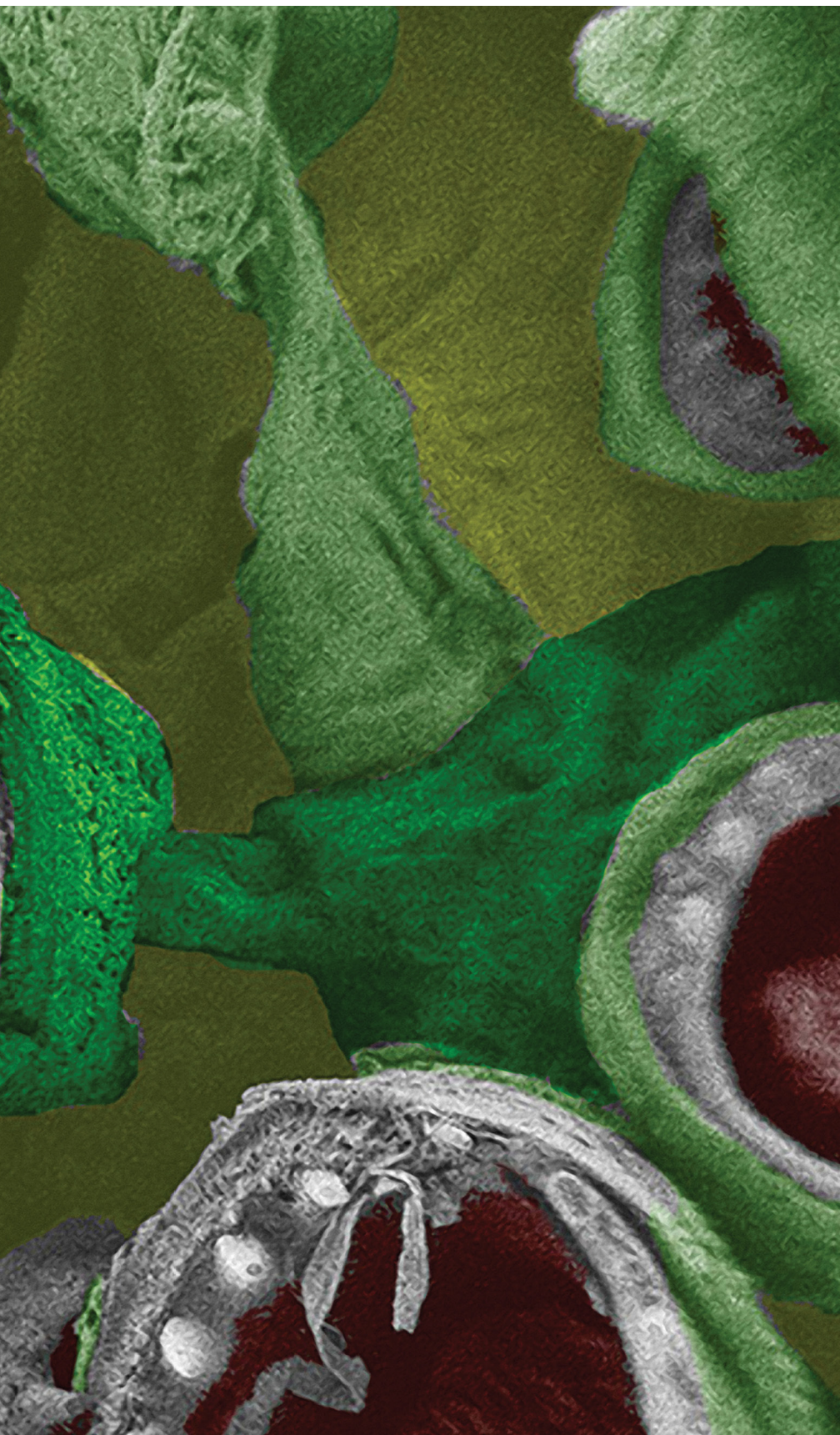
MAX Phase Research Group (Michel W. Barsoum)

Fractured surface of a nanocrystalline magnesium matrix composite reinforced with Ti<sub>2</sub>AlC. A Ti<sub>2</sub>AlC grain kinked several times during fracture to form a "dragon." The width of image is 35 $\mu$ m.







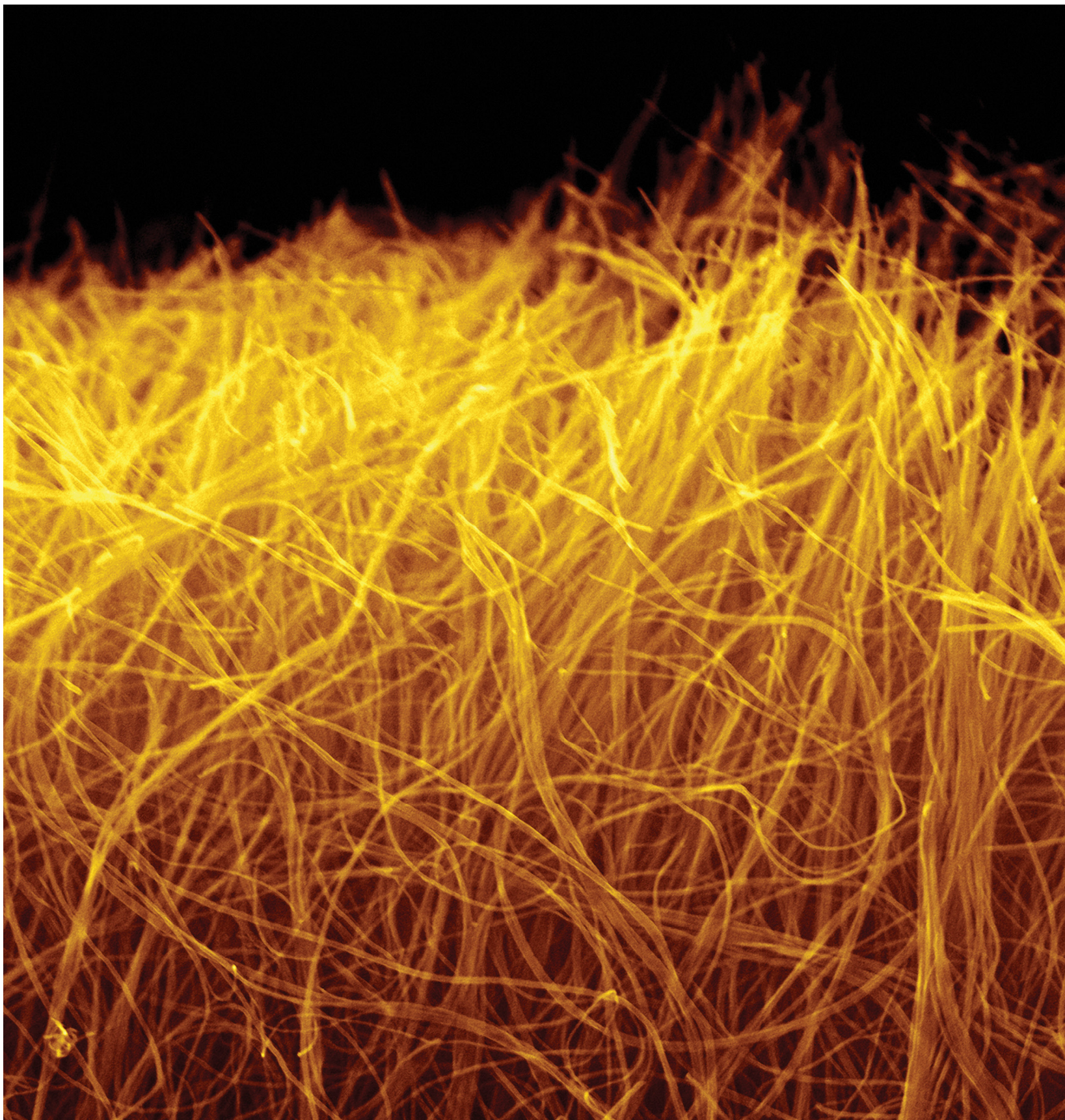


JESSICA\_SCHIFFMAN

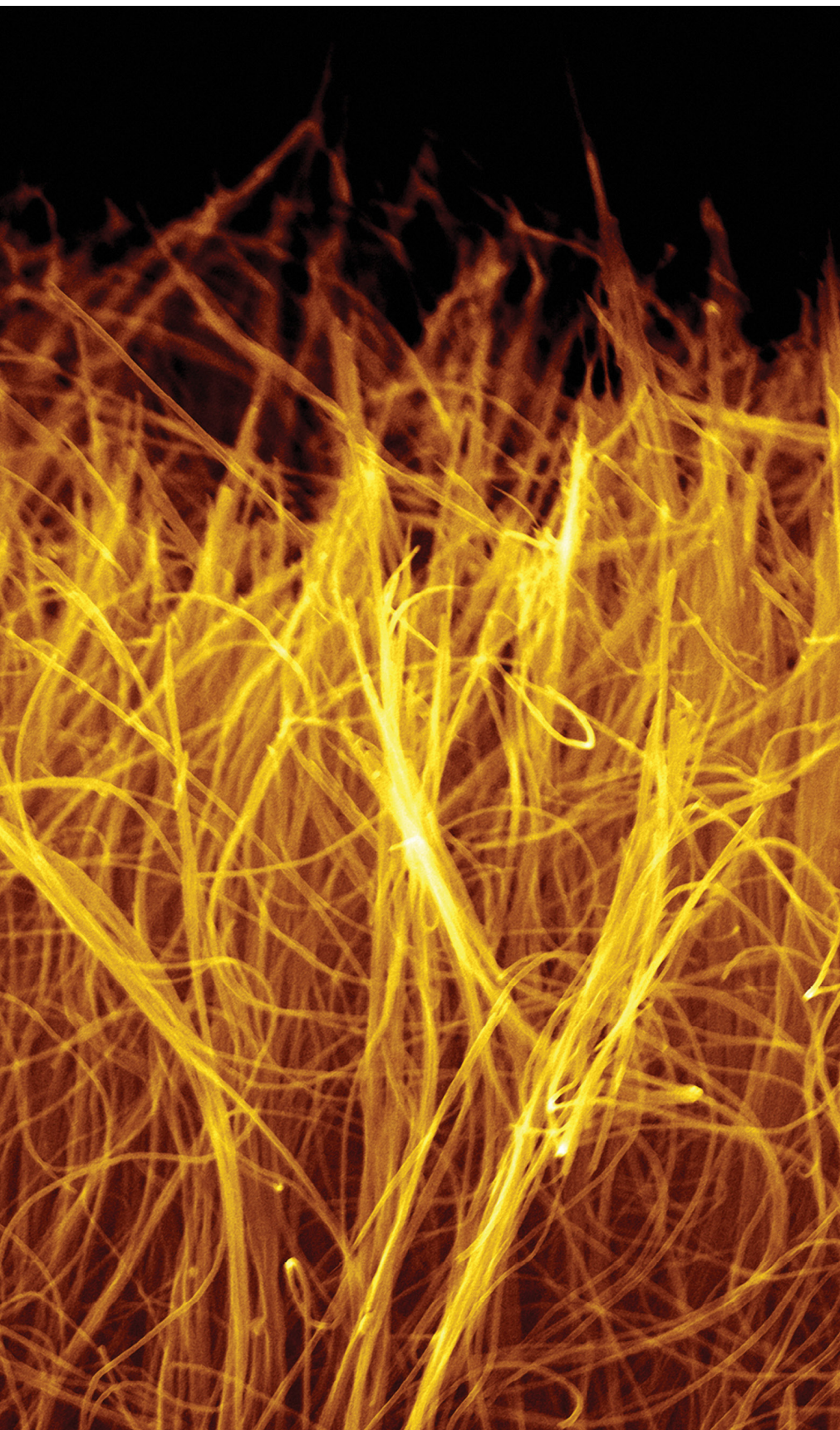
Natural Polymer and Photonics Lab (Caroline Schauer)  
Zeiss Supra 50VP SEM, CRF

Fanglike structures that make up a squid tentacle. Each small "mouth" is 400 $\mu$ m in diameter.







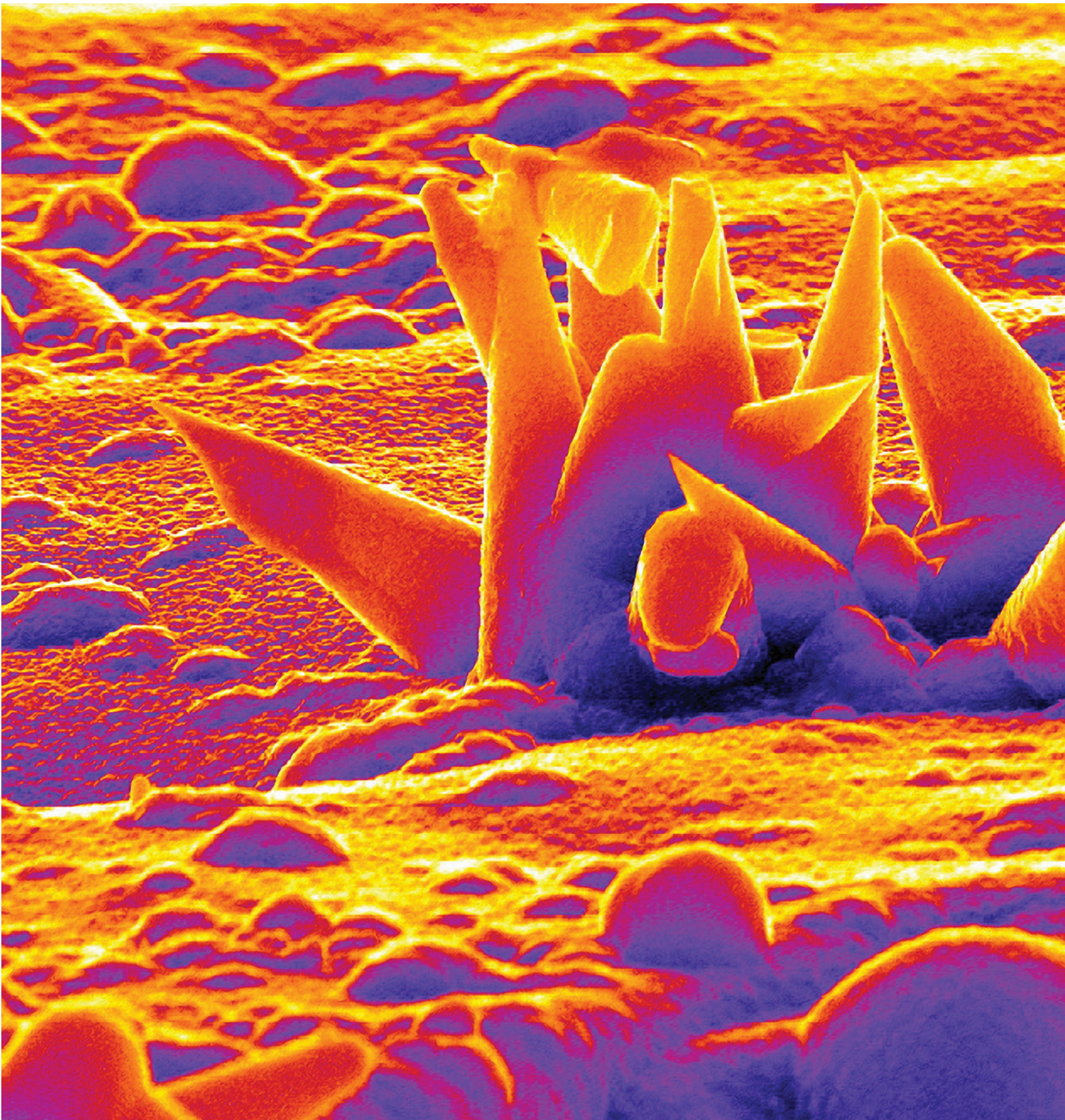


MIN\_HEON\_AND\_BORIS\_DYATKIN

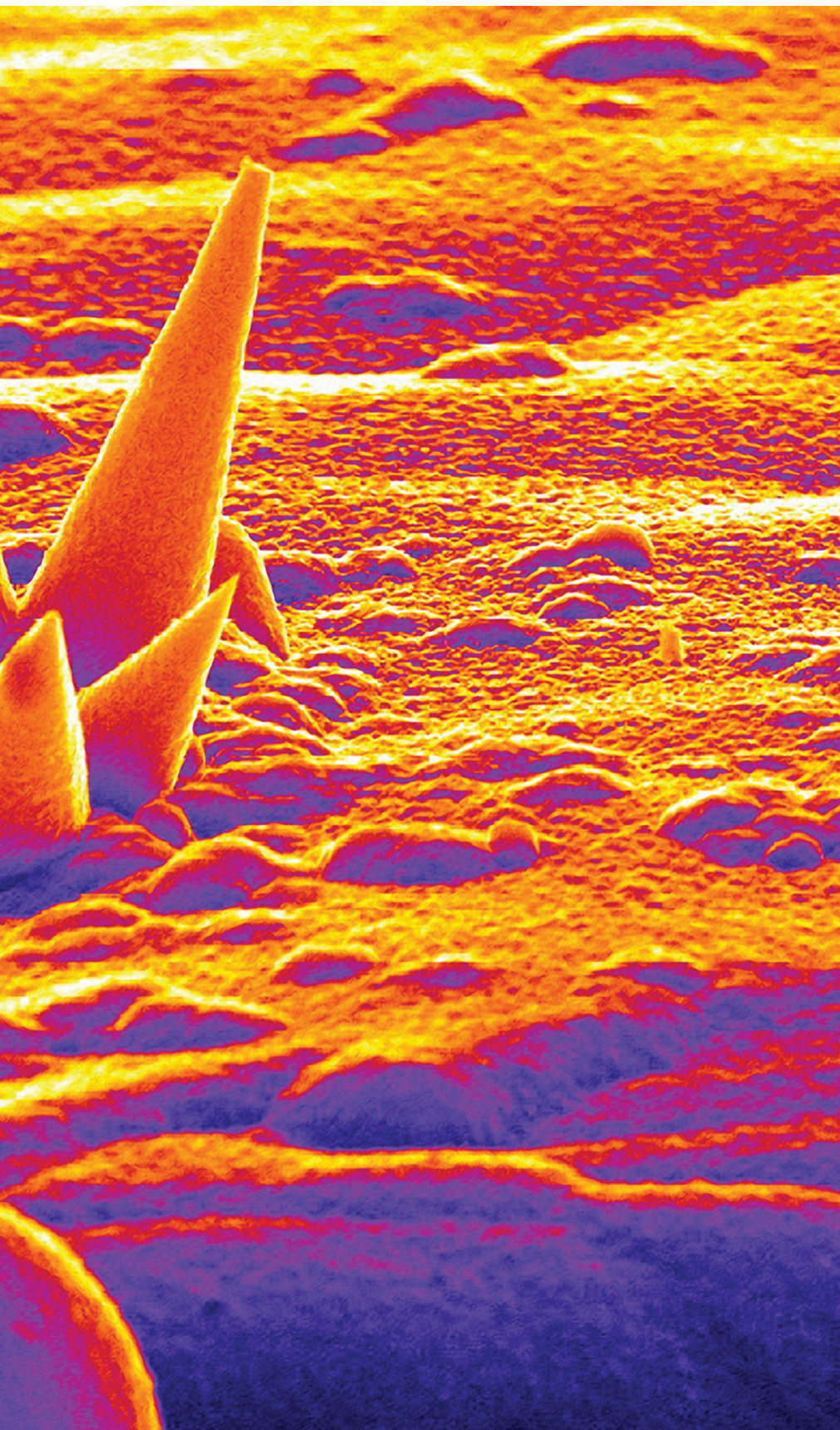
Nanomaterials Group (Yury Gogotsi)  
Zeiss Supra 50VP SEM, CRF

Carbon nanotubes in free-standing macroscale sheets (one of a few promising approaches for electric energy storage).









JENNIFER\_S.\_ATCHISON

Natural Polymer and Photonics Lab (Caroline Schauer)  
Amray 1850 FE, in the MesoMaterials Laboratory

Silicon nanocones grown in a chemical vapor deposition chamber. Tapered semiconductor nanowires have applications in solar cells, antireflective coatings and Li-ion batteries.



# \_EXEL 2012

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## THE ALLURE OF PUNISHMENT

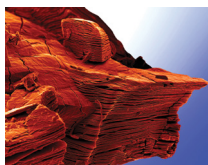
*The evidence is clear: Humans are driven to punish one another. Adam Benforado wants to know why.* \_by Mike Unger



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Intersection of Science & Art:  
**Striking images** from Drexel's  
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## THE UNDERDOGS

*Freshwater mussels get little respect and even less attention. But two Drexel researchers believe these 'underdog' species might hold the key to the longtime revitalization of the Delaware River and its tributaries.* \_by Tim Hyland



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## THE FANTASY AND THE HYPOCRISY

*Ellen Staurowsky says it's time for the nation's universities to rethink the way college athletics are managed-and the way the money it generates is distributed.* \_by Mike Unger



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## DIGGING DEEP

*Some say the Marcellus Shale formation could be an economic and environmental panacea for Pennsylvania. Others are convinced shale drilling poses environmental risks. At Drexel, researchers are working across all disciplines to find the truth about the Shale, and the natural gas locked beneath it.* \_by Maria Zanke



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Introducing *EXEL Magazine*,  
exploring research at Drexel.

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#### \_BODY OF RESEARCH

The Academy of Natural Sciences of Drexel University houses one of the oldest **entomological collections** in North America—and its method of preservation is as unique as the beautiful butterflies it protects.

68

#### A PIN-POINT SIZED CATALYST

*Drexel's Yury Gogotsi has transformed the A.J. Drexel Nanotechnology Institute into a world-class hub for studying science's smallest frontier.*  
\_by Brian M. Schleiter



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#### HUBO

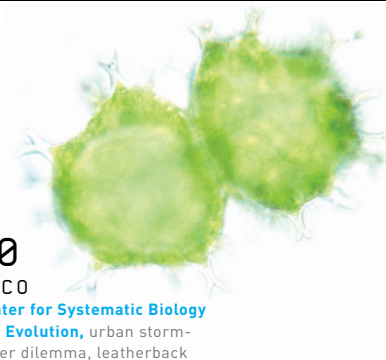
*With the help from colleagues around the world and a troupe of humanoid robots, Drexel's Youngmoo Kim is pushing the boundaries of modern robotics.*  
\_by Maria Zankey



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**Q&A with Mimi Sheller**, diabetes crisis, autism findings, **HIV breakthroughs**





# E X E L

\_DREXEL UNIVERSITY  
RESEARCH MAGAZINE  
2012

## EDITORIAL\_STAFF

### Editor

Timothy Hyland

## ASSOCIATE\_EDITORS

Maria Zanke  
Mark Eggerts  
Katie Clark  
Danica DeLizza

## STAFF\_WRITERS

Britt Faulstick  
Rachel Ewing  
Alex McKechnie  
Niki Gianakaris

## DESIGN

Pentagram

## ADMINISTRATION

### President

John A. Fry

### Senior Vice President, University Communications

Lori Doyle

### Senior Vice Provost, Research

Deborah Crawford

## EXEL\_MAGAZINE

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### Office of the Vice Provost for Research

3141 Chestnut St.  
234 Randell Hall  
Philadelphia, PA 19104  
Telephone: 215-895-6091



# \_INTRODUCING EXEL

and the amazing university behind it



## \_ABOUT THE COVER

This image of an African Round-Winged Orange-Tip Butterfly was captured by photographer Robert Clark during the second of two visits to the Academy of Natural Sciences of Drexel University in March. Clark is a longtime contributor to *National Geographic* and has also shot for *Sports Illustrated*, *Vanity Fair* and *U.S. News and World Report*.

**D**REXEL'S GROWING AND TRAILBLAZING research enterprise has been one of our best-kept secrets. But with the publication of this stunning, wide-ranging magazine, the word is out.

Our faculty and students are pushing the boundaries of knowledge and creativity from medicine to nanotechnology to robotics and beyond. They're producing unique work in digital media, in entrepreneurship and in the natural and social sciences as well as the arts and humanities.

At Drexel, we focus on ideas that are on the cusp of major real-world and marketplace impact. We are leaders in translational research producing life-saving biomedical solutions, and recently partnered with the Wallace H. Coulter Foundation to create a \$20 million endowment to help bring promising discoveries into clinical practice.

Our researchers are attacking the most important challenges facing society today. In the past year, we've created the nation's first research institute addressing the crisis of autism from a public health perspective and completed a landmark affiliation with the Academy of Natural Sciences, the nation's oldest and among the most distinguished natural history museums and scientific organizations. Together, Drexel and Academy scientists are answering critical environmental and ecosystem questions.

Research is central to our new strategic plan, "Transforming the Modern University." In particular, we want to further erase the boundaries between research specialties and harness the full potential of the incredible scholars across Drexel. In the interdisciplinary spaces we create, the next generation of Drexel innovations will take place.

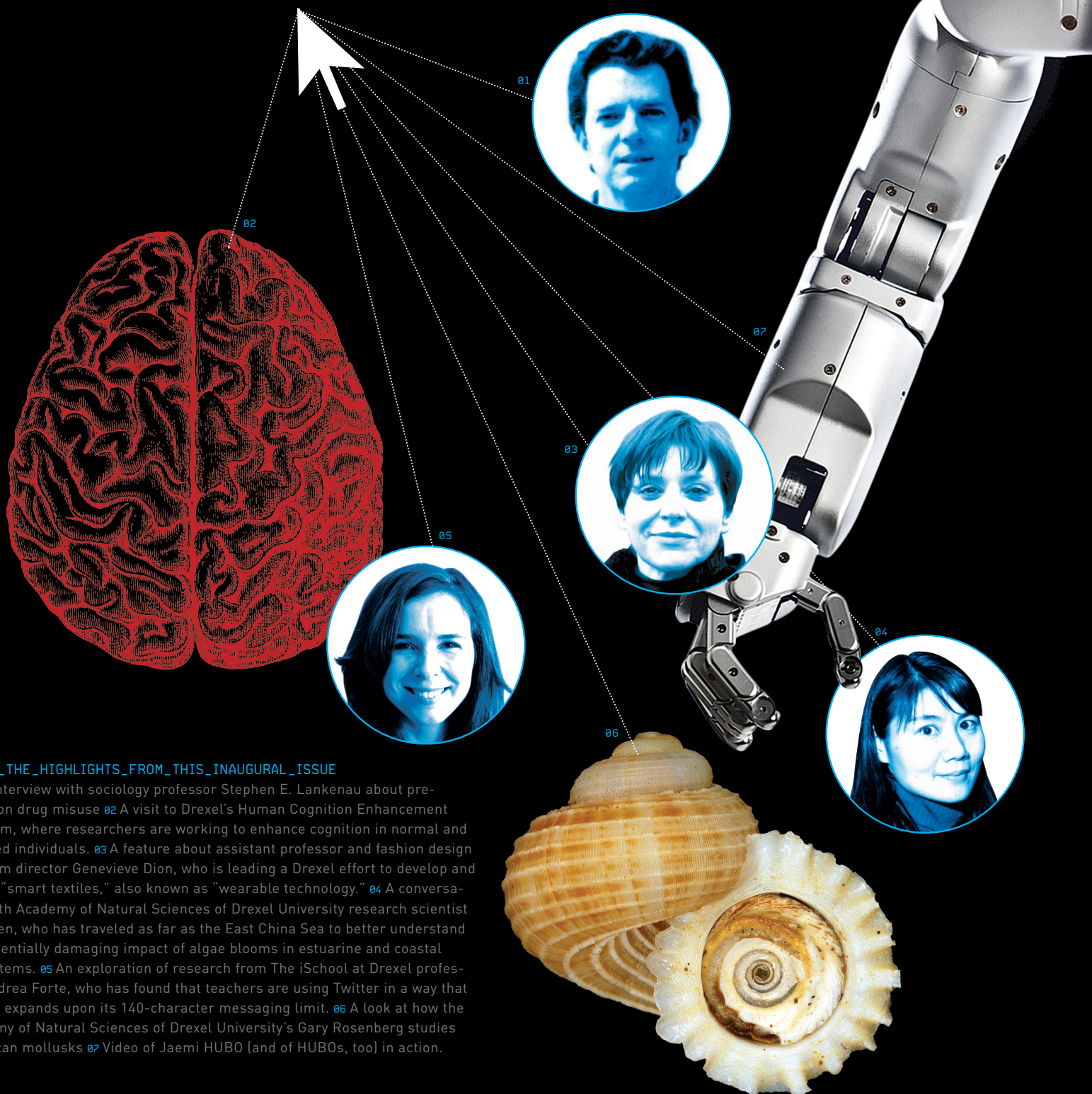
The stories and pictures in this inaugural issue of *Exel* provide a perfect introduction to the strength and diversity of research at Drexel. I am proud to present them to you.

John A. Fry / President



# \_EXPLORE EXEL ONLINE

*EXEL Magazine is also available online. Visit our site at [EXELmagazine.org](http://EXELmagazine.org) for online-only exclusive content, including interviews with Drexel researchers, videos about our exciting work, updates from our growing research enterprise and more.*



## AMONG THE HIGHLIGHTS FROM THIS INAUGURAL ISSUE

**01** An interview with sociology professor Stephen E. Lankenau about prescription drug misuse **02** A visit to Drexel's Human Cognition Enhancement Program, where researchers are working to enhance cognition in normal and disabled individuals. **03** A feature about assistant professor and fashion design program director Genevieve Dion, who is leading a Drexel effort to develop and create "smart textiles," also known as "wearable technology." **04** A conversation with Academy of Natural Sciences of Drexel University research scientist Ling Ren, who has traveled as far as the East China Sea to better understand the potentially damaging impact of algae blooms in estuarine and coastal ecosystems. **05** An exploration of research from The iSchool at Drexel professor Andrea Forte, who has found that teachers are using Twitter in a way that greatly expands upon its 140-character messaging limit. **06** A look at how the Academy of Natural Sciences of Drexel University's Gary Rosenberg studies Jamaican mollusks **07** Video of Jaemi HUBO (and of HUBOs, too) in action.



## \_IMAGING, REIMAGINED

At the Academy of Natural Sciences of Drexel University, researchers are using **X-ray technology** to better analyze their fish collections—and better preserve valuable type specimens, too.



**\_JOHN LUNDBERG**  
Lundberg is the curator and chaplin chair of Ichthyology at the Academy. His research focuses on fish diversity in South Africa, and his taxonomic specialties are catfishes and electric fishes.

WITH THE simple click of a mouse, a longer, richer, and increasingly valuable life is bestowed upon the deeply treasured dead things of the Academy of Natural Sciences of Drexel University. Using high-tech imaging equipment, scientists in the department of ichthyology are permanently digitizing nearly 3,000 type specimens, those prized “originals” that give tremendous value to any natural history collection.

This state-of-the-art imaging system now used by the Academy has changed the way scientists study fish, as well as how they protect and share biological collections. This digital system, acquired in 2008, replaced the outdated film and chemical setup and reduces a once tortuous process in the darkroom to a few seconds.

The Academy is one of only a few institutions using this digital X-ray system for imaging specimens.

“Digital images capture minute anatomical detail and increase the accuracy and precision of complex morphological description and under-

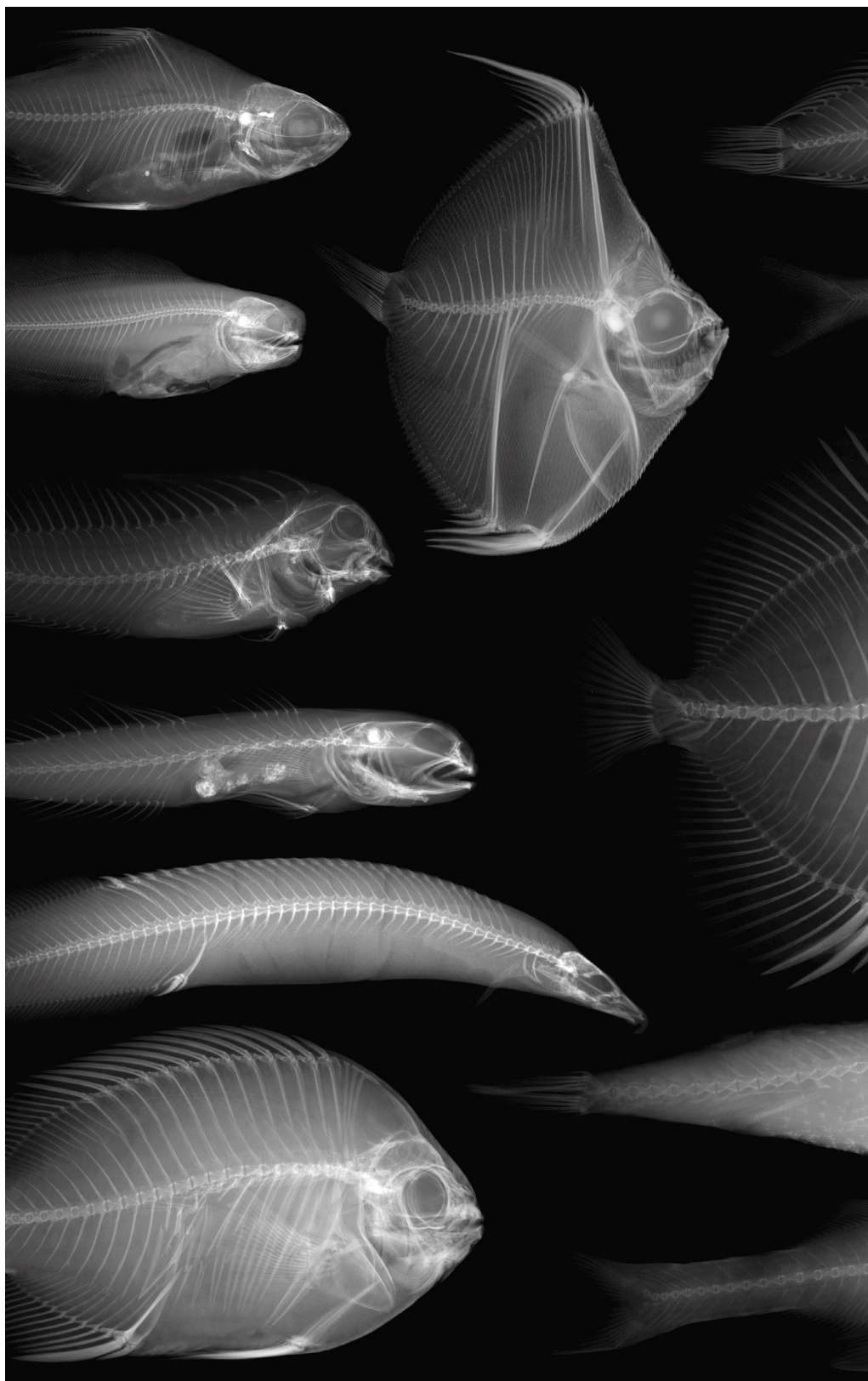
standing,” says department curator John Lundberg.

The department has already digitized roughly 1,500 type specimens (a “type” is the specimen on which species descriptions and scientific names are based). Academy staff members digitally photograph each specimen and then use the equipment to create a high-quality radiograph of the fish, which allows researchers to view the specimen from the inside out, or more like “the outside, through.”

Every living thing on Earth possesses features, or “characters,” used by scientists to distinguish one species from another. In fishes, many of these characters occur in the skeleton, such as the bones of the fins or backbone. In order to physically examine the bones, scientists must first rely on the appetite of meat-eating dermestid beetles to pick clean a specimen, leaving only the skeleton, a rather lengthy process that leaves the fleshy parts of the specimen forever destroyed.

There are many benefits of these radiographs. An online database of these images allows researchers to study the specimens from anywhere in the world—a true benefit for a scientist with a limited research budget. And, sending a digital file is preferred over the risks involved in loaning a specimen through the mail.

“Type specimens are so special—you don’t want to take a chance on losing them or damaging them,” Lundberg says.







#### FRESH\_WATERS

The Academy's Ichthyology Collection has one of the largest and most diverse collections of type specimens in the world. Highlights among the types are species described in the 19th century by some of the founding fathers of North American ichthyology, including Charles Alexandre Lesueur, John Edwards Holbrook, Theodore Nicholas Gill and Edward Drinker Cope. Also included are more than 400 types collected by Charles Lucien Bonaparte, nephew of Napoleon Bonaparte.



## \_COMING SOON: ROBOFISH

Drexel researchers are working with colleagues at Harvard and the University of Chicago to develop **robotic fish** that could serve the U.S. Navy.



\_JAMES TANGORRA

Tangorra is an assistant professor of mechanical engineering, with research focuses on biorobotics, human performance and appropriate technology.

A **ROBOTIC FISH** developed by Drexel engineers could be the key to developing more sophisticated, unmanned and automated marine systems for the United States Office of Naval Research.

The College of Engineering's Laboratory for Biological Systems Analysis, led by James Tangorra, an assistant professor of mechanical engineering and mechanics, received a \$1.1 million pledge over the next three years from the Office of Naval Research to research the multifunctional nature of rayed fish fins using behavioral observations, robotic and mathematical models.

"This grant provides us the opportunity to conduct detailed behavioral and neuromechanical studies of the fish and to use the results to inform the design of very advanced models of the fish's propulsive and sensory systems," says Tangorra, whose team will collaborate with Harvard University and the University of Chicago.

The robotic fish, which is modeled after a bluegill sunfish, is being used to understand the movement and sensory abilities of fish fins.

"Although we've mainly considered the pectoral fin as a propulsive device, it's highly likely that the fin is also a very sensitive sensory system," Tangorra says of the real, cold-blooded fish. "The pectoral fin has afferent nerves and free nerve endings throughout its webbing.

"We are investigating if these sensory nerves provide information that is used to make propulsion

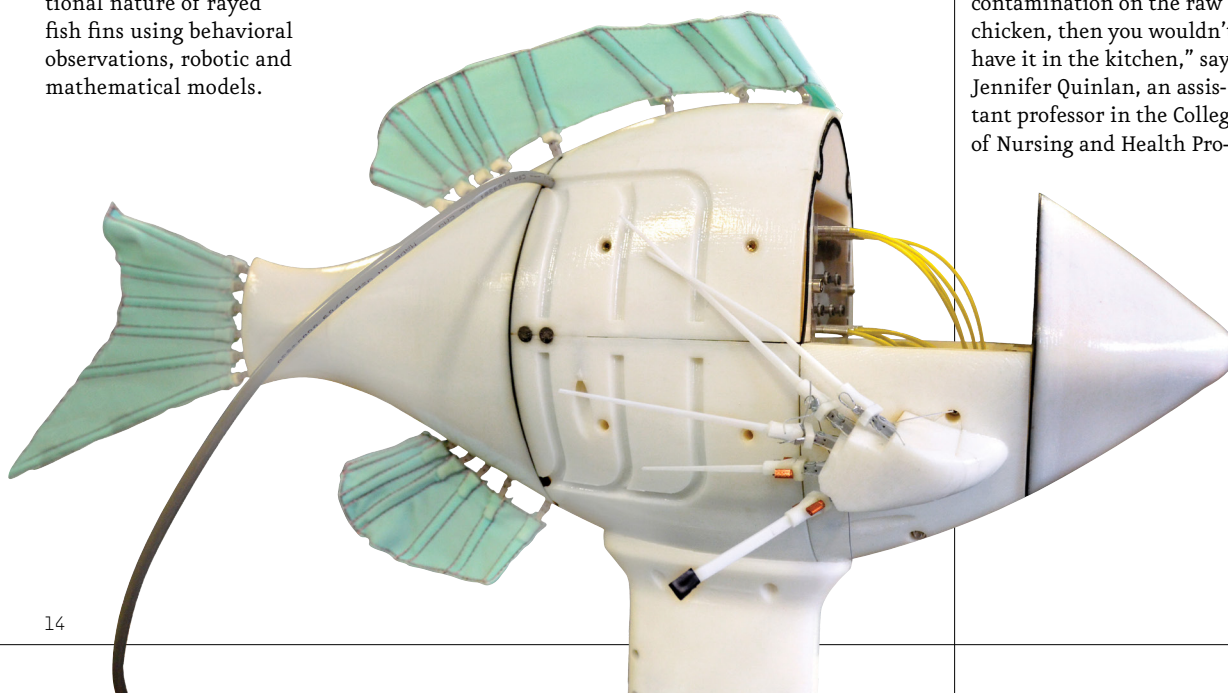
more effective and that helps the fish sense and interact with the water and other fish," he adds.

The bluegill sunfish was chosen as a biological model because it represents a class of fish that use multiple fins in many different fin gaits acting on an unstable body to move through their aquatic environment.

Tangorra and his team hope to gather knowledge from the study for the Office of Naval Research to use in developing an unmanned, autonomous platform that could help advance naval capabilities in MCM, ASW, swimmer defense, surveillance and inspection and identification of hulls, harbors and piers.

## \_LIKE\_A\_FISH

Once developed, the robotic fish will be capable of navigating through a complex environment using its fins to propel itself through water, sense its surroundings and react accordingly.



## \_PLASMA FOR POULTRY

Food safety researchers at Drexel may have found a way to **stop the spread** of foodborne bacteria.



I N A proof-of-concept study that was published in the January 2012 issue of the *Journal of Food Protection*, researchers have demonstrated that plasma can be an effective method for killing pathogens on uncooked poultry.

The most common source of harmful bacteria in food is uncooked poultry and other meat products. *Campylobacter* and *salmonella*, the two bacteria most responsible for foodborne illnesses, are found on as much as 70 percent of chicken meat tested.

"If you could reduce contamination on the raw chicken, then you wouldn't have it in the kitchen," says Jennifer Quinlan, an assistant professor in the College of Nursing and Health Pro-

## \_HIGH-ENERGY\_MIX

Plasma has a wide range of potential applications, including energy production and control, biomedical treatments and environmental remediation.

fessions and senior author of the study.

Previous studies have shown that plasma could successfully reduce pathogens on the surface of fruits and vegetables without cooking them.

In the Drexel study, raw chicken samples contaminated with *salmonella enterica* and *campylobacter jejuni* bacteria were treated with plasma. The treatment either entirely or nearly eliminated bacteria in low levels from skinless chicken breast and chicken skin. It significantly reduced the level of bacteria when contamination levels were high.

Brian Dirks, a lead author and graduate student in the College of Arts and Sciences who worked on the study with researchers from the Anthony J. Drexel Plasma Institute, says the value to using plasma is that it is "non-thermal, so there is no heat to cook or alter the way the food looks."



## \_MEET THE BEETLES

Drexel scientists are learning lessons about the aerodynamics of aircraft flight through one of nature's most powerful flying insects: the rhinoceros beetle.

WITH THE help of scientists in Drexel's mechanical engineering department, rhinoceros beetles could play a big part in the next generation of aircraft design.

MinJun Kim is leading a team of engineers in National Science Foundation-funded research that examines the function and aerodynamics of the *Allomyrina dichotoma* beetle in collaboration with Konkuk University in South Korea.

Kim's research aims to study the movements of a beetle's wing by controlling its motion remotely via four tiny electrodes implanted in its body. The team then films the flight of the beetle from takeoff to landing while electrical currents direct the extension, contraction, direction and flapping frequency of the wings.

"A quantitative investigation of aerodynamics and wing kinematics in beetle flight will shed new light on the evolution of flapping flight in nature," Kim says.



The use of a wind tunnel allows the researchers to see how air currents move around the wings they flap during flight.



The beetle's size, which is 7 to 9 centimeters as an adult, is large enough to allow engineers to implant electrodes in both optic lobes, the central nervous system and the abdomen without harming it.

### TAKING FLIGHT

In the rhinoceros beetle, Kim's team has found what could be the perfect candidate for the controlled study of biological flight capabilities. It is a powerful flying creature for its size, having the ability to take flight directly from the ground.



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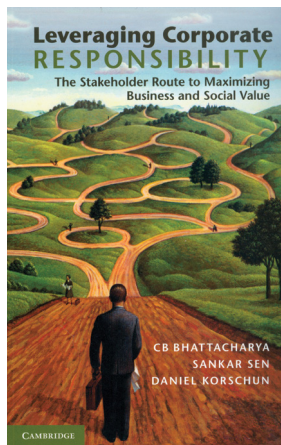
## \_CORPORATE RESPONSIBILITY

**N**EARLY EVERY large company runs corporate responsibility programs, but the larger public—and the companies themselves—may not fully understand what corporate responsibility actually is. Daniel Korschun, a LeBow College of Business marketing professor, recently co-authored the book *"Leveraging Corporate Social Responsibility – The Stakeholder Route to Maximizing Business and Social Value,"* in an effort to help companies navigate the complex world of corporate responsibility and ultimately maximize their corporate social responsibility efforts.

Korschun notes that it is widely accepted that corporate social responsibility programs can improve both corporate performance and societal welfare. It is therefore no longer a question of whether or not these programs have the potential to benefit companies; rather,

## LEARN\_MORE

*Corporate Social Responsibility: The Stakeholder Route to Maximizing Business and Social Value* is currently available and can be purchased on Amazon.com.



**\_DANIEL KORSCHUN**  
Korschun is an assistant professor of marketing with expertise in brand and corporate reputation management, corporate social responsibility, internal marketing and strategy.

the issue is what companies can do to ensure that corporate responsibility pays off as much as possible.

Corporate responsibility is a type of community engagement that has existed for some time and has been the subject of a number of books. However, this book is one of just a few that use empirical research to get at the actual worth of corporate responsibility programs.

The authors' own research, compiled over the course of a decade through experiments, surveys, focus groups, interviews and analysis of secondary data, is at work throughout the book. Says Korschun: "Our hope is that readers use our approach to create [corporate responsibility] programs that not only provide societal benefits, but also benefits for the company. That way, the programs themselves will become sustainable."

❶ Korschun co-wrote this book with Sankar Sen, professor of marketing at the Zicklin School of Business; CB Bhattacharya, dean of international relations and E.ON chair in corporate responsibility at the European School of Management and Technology.

## \_MUSIC THERAPY



**L**ISTENING TO music can reduce anxiety in cancer patients and may also have positive effects on mood, pain and quality of life, according to a Cochrane systematic review led by Joke Bradt, an associate professor in the Department of Creative Arts Therapies in the College of Nursing and Health Professions.

Music and music therapy are used in a wide range of clinical settings—treatments range from patients listening to pre-recorded music, to music therapists engaging patients in music experiences to improve psychological and physical well-being. In their review,

## LISTENING\_CLOSELY

Further research could help increase certainty in the findings and improve understanding of music's impact on distress, body image and other aspects, for which research is currently too scarce to draw conclusions.

researchers focused on trials with patients with cancer who were offered music or music therapy sessions.

The researchers analyzed evidence from 1,891 patients taking part in 30 trials. Thirteen trials used trained music therapists, while in the remaining 17 trials, patients listened to pre-recorded music. The length and frequency patients participated in music sessions

varied greatly among trials.

The results show that, compared to standard treatments, music considerably reduced anxiety based on clinical anxiety scores. While some trials reported more beneficial effects than others, the results also suggest that music therapy may increase patients' quality of life.

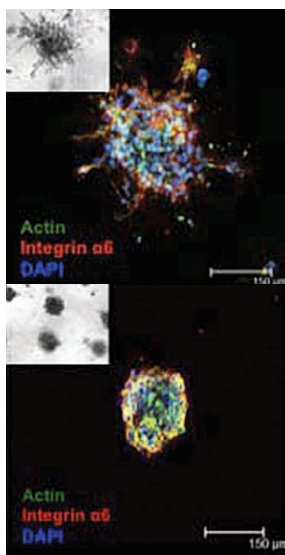
"The evidence suggests that music interventions may be useful as a complementary treatment to people with cancer," Bradt says. "Music interventions provided by trained music therapists as well as listening to pre-recorded music both have shown positive outcomes in this review."



## MEDICINE

## SPORTS MEDICINE / PSYCHOLOGY

## \_CANCER DISCOVERY



## A\_SUGAR\_SOLUTION?

A Drexel Medicine researchers says a naturally occurring sugar appears to play a key role in the growth of prostate cancer. Suppressing this sugar, he says, could help fight the cancer in years to come.



## \_MAURICIO J. REGINATO

Reginato is an associate professor of biochemistry and molecular biology with research interests in breast and prostate cancer, oncogenic signaling, cancer metabolism, cell adhesion signaling and more.

FOR THE first time, researchers at Drexel University College of Medicine have discovered that a certain type of sugar found naturally in the body is elevated in prostate cancer cells and plays a critical role in the growth of cancer.

The research team previously identified a spe-

cific type of sugar that was elevated in breast cancer cells, which plays a critical role in the growth and movement of breast cancer. Now, the research team has discovered that this same sugar is also elevated in prostate cancer and also aids in multiplying and metastasis of the disease, which is the second leading cause of cancer-related death in the United States among men.

"This sugar, O-GlcNAc, is used inside cells to tag proteins and alter their function. Cancer cells become very dependent on this sugar for growth and spread," says the study's lead researcher Mauricio J. Reginato, associate professor in the Department of Biochemistry and Molecular Biology. "We've known for a long time that cancer cells are addicted to sugar. With the evidence that this sugar is elevated in both prostate and breast cancer development, we may, in the future, be able to develop ways to suppress this sugar, which could lead to more targeted treatment protocols for these types of cancer."

In the study, O-GlcNAc was found to be elevated in a panel of prostate cancer cell lines. Normalizing the levels of O-GlcNAc significantly reduced the spread and growth of such cells. The researchers have found that prostate cancer cells, with reduced levels of O-GlcNAc, had a significant reduction in the incidence of bone metastasis.

This study indicates that targeting the enzyme that adds this sugar to proteins could have therapeutic potential in the treatment of several types of cancers.

## \_BRAIN POWER

*Drexel's Human Cognition Enhancement Program is breaking down departmental barriers to generate groundbreaking, comprehensive brain and behavioral research.*

WHEN TREATING athletes who had suffered mild concussions, the College of Medicine's Dr. Gene Hong noticed something peculiar.

For the first few appointments, his patients would arrive at his office accompanied by a parent. But after a few visits, many students started showing up alone. They had decided they could safely drive themselves to see him.

The problem is, they may not have been able to yet.

Hong knew many were still recovering from their brain injury. But because there is no empiric data to definitively show impaired driving ability with a concussion, it's hard for a physician to know when an affected person is ready to safely resume driving or return to the playing field.

Through Drexel's novel Human Cognition Enhancement Program (HCEP), Hong, who is chair of the College of Medicine's family, community and preven-

tive medicine department and chief of the sports medicine division, has connected with Dr. Maria Schultheis, an associate professor in psychology in the College of Arts and Sciences, to explore the capabilities of concussion patients in a computer-based driving simulator. Together they applied for and received National Institutes of Health funding that is enabling Hong and Schultheis to get hard data on his patients' performance in the simulator.

Created in 2009, HCEP facilitates these types of unique research collaborations across schools, colleges and departments, offering networking opportunities for graduate and undergraduate students and faculty to broaden their exposure outside their fields. By bringing together people who can contribute knowledge and expertise from various backgrounds and disciplines, HCEP is breaking down the academic silos that would

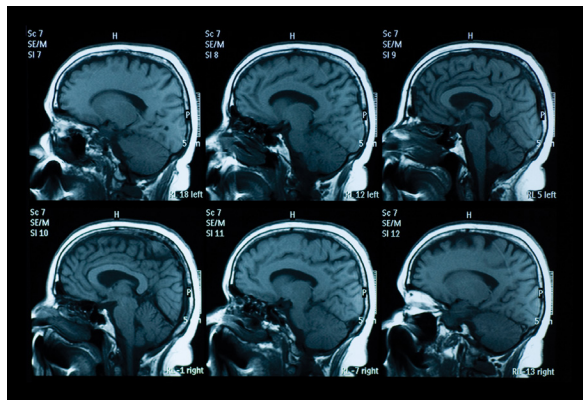
*"You need structures—even if they're not physical—to bring people together and start talking about things they're interested in with people who have different perspectives."*

—Barry Waterhouse,  
HCEP scientific director

otherwise stymie research into brain and behavior relationships.

"It's an unfortunate truth in university cultures that although we prosper in our own disciplines, we don't usually cross-fertilize too far afield from our primary expertise," says Barry Waterhouse, a professor in the College of Medicine's department of neurobiology and anatomy and HCEP's scientific director. "But you need structures—even if they're not physical—to bring people from different fields together and start talking about things they're interested in with like-minded people who have different perspectives and technical skills."

Though still a relatively young program, there are nine ongoing research collaborations within HCEP, two of which have received NIH funding. The hope is that the projects fostered through HCEP will grow into centers and institutes and foster new undergraduate majors and areas of study.



## BRAIN\_SCAN

HCEP encourages medical students studying neurobiology to think about clinical problems such as ADHD, autism and brain injuries.



## \_BETTER HEALING

Researchers at the College of Medicine have developed a non-invasive device to measure the oxygenation of wounds, a technique that could improve patient outcomes-and save time and money, too.

It has long been believed that a decrease in the surface size of a wound is an appropriate indication of how well the wound is healing. But scientific literature reveals that this is not the case, especially in regard to irregularly shaped wounds. In fact, a decrease in wound size only has a 58 percent correlation to actual healing.

With this in mind, researchers at the Drexel University College of Medicine and the School of Biomedical Engineering, Science and Health Systems—led by Dr. Michael S. Weingarten—have developed a device that can improve the assessment of wound healing, allowing physicians to treat and manage chronic wounds more effectively.



75,000

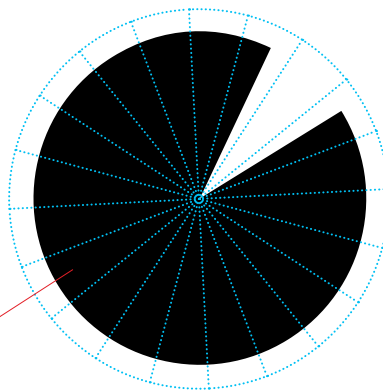
In the United States, the number of chronic wounds associated with disease reported by doctors each year.

\$5  
BILLION

Annual health care costs associated with those wounds.

24

Number of wounds studied by the Drexel research team during their work, which aimed to quantify just how much the device could improve wound-healing treatment.



91%

Accuracy shown by the device over the course of a 20-week study.



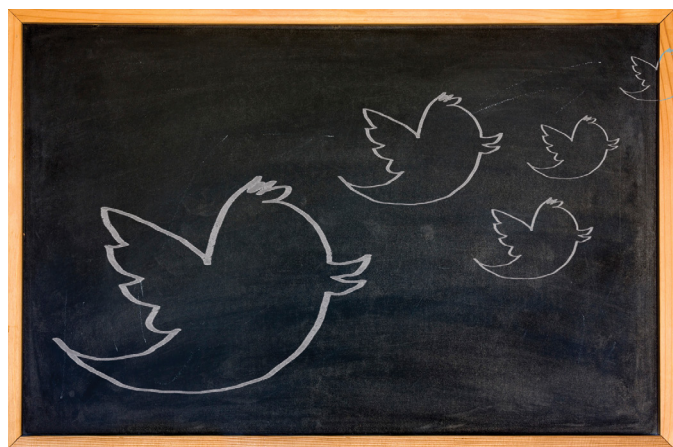
\$1,800

Per-week cost of the most expensive wound therapies.



## SOCIAL MEDIA

## \_TWEETING TEACHERS



**\_ANDREA FORTE** Forte is an assistant professor in The iSchool at Drexel. Her work tackles questions about human-computer interaction, computer-supported cooperative work, online communities and learning sciences.

**T**EACHERS ARE stretching Twitter's reach beyond just 140 character quips, according to a new study by researchers at The iSchool at Drexel.

The study suggests that teachers are reimagining Twitter from its common perception as a social medium for sharing personal information and observations into a conduit for disseminating educational resources and connecting with distant colleagues.

The research notes that while 80 percent of all Twitter users are "meformers"—people who include personal information and status updates in their tweets—only 2.5 percent

of teachers' tweets contain personal information. By contrast, educators tend to use Twitter to connect with distant colleagues, sharing and discovering new ideas and teaching resources, according to the study.

Andrea Forte, assistant professor in The iSchool at Drexel, undergraduate Melissa Humphreys and Ph.D. student Thomas Park conducted the research using data collected from a Web-based survey, telephone interviews and content analysis of 2,000 tweets from teachers and education-related hashtags.

"Often people think of social media like Twitter in one of two ways," Forte

*"Many people are using these media in really important everyday ways. Like sharing information that helps them do their jobs better."*

—Andrea Forte, assistant professor in The iSchool at Drexel

says. "Either it's mundane: a place to broadcast what you ate for breakfast, or revolutionary: a place to coordinate overthrowing your government. Actually, many people are using these media in really important everyday ways, like sharing information that helps them do their jobs better. It's likely that other groups of professionals are using these tools in precisely the same ways."

The study's data also indicate that the vast majority of people followed by teachers on Twitter are distant teachers, rather than local teachers, students or parents. Teachers interviewed in the study also indicated that they see social media as an important tool for learning and will take the next step by teaching their students how to effectively use social media.

**i** Forte has been an assistant professor at The iSchool at Drexel since 2010. Her research focuses on how people adapt to and use new technologies, including social media. She will present the research at the International Association for Advancement of Artificial Intelligence's International Conference on Weblogs and Social Media at Trinity College in Dublin, Ireland in June.

## \_IT'S WHO YOU KNOW

**F**OR SUCCESS ON Wall Street, who you know could trump what you know.

In a research paper titled "The Price of Street Friends: Social Networks, Informed Trading and Shareholder Costs," a group including Drexel researchers found that social ties significantly increase a firm's trading costs.

The paper, written by Jie Cai, LeBow College of Business professor of finance, and Ralph Walkling, Stratakis Chair in Corporate Governance and Accountability and executive director of LeBow's Center for Corporate Governance, was recently awarded the Outstanding Paper recognition in the investments category for the 2011 Southern Finance Association Annual Meeting. Ke Yang of Lehigh University also co-authored the paper.

Examining more than 18,000 firm year observations, the group studied whether the social ties between a public firm and the professional investment community impact the cost of trading.

"Our evidence illustrates the importance of social ties in the transfer of privileged information and the significant consequences for shareholders," the paper states.

Executives and directors of a firm, the paper explained, have social connections with Wall Street executives through activities including education, employment or leisure.

*"Our evidence illustrates the importance of social ties in the transfer of privileged information and the significant consequences for shareholders."*

—excerpt from *The Price of Street Friends: Social Networks, Informed Trading and Shareholder Costs*

Information flows through these channels—sometimes through non-verbal social cues—ultimately influencing a firm's trading cost.

The findings published in the paper indicate that one executive or director connected to Wall Street increases a firm's annual trading cost by as much as \$1.3 million. With as many as eight connected directors and executives throughout the typical life of a firm, shareholder wealth could be reduced by as much as \$213 million.

"When Wall Street connections die, trading costs are reduced," the paper states.

Walkling says the study of social ties in finance is relatively new.

"This research offers new insights into previously unexplored areas related to informed trading," he says. "One particularly interesting aspect of the social ties idea is the way information can be transferred even inadvertently through non-verbal cues. For example, we could observe the purchase of an expensive car, the cancellation of a shared vacation or the repeated absence at a social event."

**\$1.3M**

amount by which one executive or director connected to Wall Street increases a firm's annual trading cost







# THE ALLURE OF PUNISHMENT

*The evidence is clear: Humans are driven to punish one another. Adam Benforado wants to know why. [by Mike Unger](#) / [illustrations by Brad Holland](#)*

PUNISHMENT IS NEARLY as old as crime itself. Ever since the first Neanderthal snuck into his neighbor's cave and was caught red-handed stealing raw meat, humans have been punishing one another for wrongdoing.

But what are the motivations behind punishment?

That's what Adam Benforado, assistant professor at Drexel's Earle Mack School of Law, is trying to find out. He applies insights from the mind sciences—most notably embodied cognition, moral psychology and implicit social cognition—to law and legal theory.

Benforado and his research partner, Geoffrey Goodwin of the psychology department at the University of Pennsylvania, are particularly interested in better understanding the nature of retribution.

"A lot of the emphasis in the legal profession is on the fact that we punish because we're very focused on avoiding future bad consequences," Benforado says. "We want to deter bad actors, you might want to deter the person who has committed the crime from doing it again, [or] you might want to deter other would-be wrongdoers. That's general deterrence.

"You also want to potentially incapacitate dangerous people. One of the things I had always wondered about was whether that was actually what was driving people at a deeper level. When people supported the death penalty for a serial killer or suggested that a rapist should be thrown away without a key, was that really about future concerns or was it something more related to retribution?"

Benforado and Goodwin, who first bonded over a shared love for the Liverpool Football Club of the English Premier League, both felt research in this area was lacking. Isolating factors that were uniquely related to retribution from those that had to do with general deterrence and incapacitation proved problematic.

A novel approach was needed. So instead of asking people how they might punish human beings, the researchers asked them how they would punish animals.

## PUNISHING JAWS

Their initial hope was that by looking at people's attitudes toward punishing a shark or a dog, the researchers could eliminate general deterrence as a punishment motivation.

"It doesn't make any sense for people to think that the killing of a shark by authorities several days after the shark at-

tacked a little girl could prompt other sharks to say, 'Hey you know what happened to Bill? He was killed because he bit a little girl three days ago. We better not bite any girls in the future,'" Benforado says.

They still needed to rule out the possibility of incapacitation as a motive for punishment. To do this, they employed several tactics.

One experiment consisted of presenting a scenario in which an animal perpetrator was sentenced to death. Participants were only exposed to the level of pain induced by the killing method. The study showed that participants believed a more painful death was appropriate for an animal perpetrator who had seemingly acted without provocation to kill a more sympathetic victim, causing the victim to suffer significantly. Since the animal was certain to be killed in all of the experimental conditions, incapacitation could not distinguish between them.

"What we find in our research is that people do have retributive desires to punish animals that have killed human beings—and those desires don't differ significantly from retributive desires aimed at human beings," Benforado says. "There is good evidence for people being driven to deliver just deserts in proportion to the harm created and the wrongness of the bad act. For example, we find that people are very sensitive to information about the nature of the victim. People believe that a shark is much more deserving of being killed if it attacks a little girl, as opposed to an older homeless man or a dog."

Likewise, Benforado points to the importance people attach to tracking down and killing the actual guilty party, rather than a simple "stand-in."

In another experiment, the researchers described a scenario in which, after a shark attack, the local authorities hunted down the perpetrator. Some subjects were told that testing proved that the authorities had caught the actual shark that killed the victim, while others were told that they caught a similar shark, but not the actual one that committed the attack. The logic of the study was that if someone is interested in punishing purely for incapacitation, the only thing that should matter is eliminating sharks that pose a future danger—guilt or



**ADAM BENFORADO**  
Benforado is an assistant professor of law, with an interest in applying insights from the mind sciences to law and legal theory.

*Instead of asking people how they might punish human beings, the researchers asked how they would punish animals.*



innocence for past misdeeds should be irrelevant, except to the extent that it reveals something about future dangerousness.

"We find evidence that it's essential for people to kill the right animal, the actual perpetrator, as opposed to an equally dangerous animal of the same size and species," Benforado says. "The reason that people punish is not about making us safer in the future—if in fact that was the case, people should feel any dangerous shark near the beach ought to be put down—but we find people really care a lot about whether this is an evil animal that has transgressed."

#### SHOULD RETRIBUTIVE PRINCIPLES BE WRITTEN INTO LAW?

There is a debate raging in the legal community now about the level to which retribution ought to guide legal processes and procedures, Benforado says.

"In order to start to answer that question, you need to know what people's actual instincts are," he says. "Imagine you were sitting on a jury, and it happens to be a little girl who is the victim, versus, say, a grown man. How does that influence how you perceive the crime and the appropriate level of punishment? If the bad actor caused the victim pain or suffering, how does that impact your ultimate decision? Is that impact something that we want to prevent? Do we want all victims to be treated equally?"

"When it comes to punishment, our research suggests that the magnitude of the perceived loss is quite consequential. Are we comfortable with a world in which an individual who sets

a bomb that kills a little girl is executed while one who by pure chance ends up killing a seeing-eye dog is not?"

Benforado says he has not taken a position on these questions yet, but he feels passionately that to answer them appropriately, scholars and policymakers need to

know more about the nature of punishment.

"There is a group of powerful legal scholars who have been working hard to try to get retributive principals more into legal codes and to quite explicitly encourage legal actors to take retributive principals into concern," he says. "At this point in our project, we are not picking a position on whether that retributive revolution is a good thing. But I think it's possible to read our work and actually say that because retribution appears to be operating at this very basic level, and because retribution can be directed at entities that we don't generally believe ought to be a target of punishment, maybe that is a reason to be weary of attempts to assert more retributive principles into law."

Benforado suggests that his current research may have implications in a number of other areas as well, including the issue of criminal liability for corporations.

"When a corporation is implicated in a harm that has occurred, is it appropriate to punish the corporation itself, as opposed to simply the people that run the corporation?" he says. "There are people out there who say, 'That's crazy. A corporation is a legal fiction. It lacks the necessary capacity to

be punished.' I think that our research sheds some interesting light on this debate because it shows that people's punishment motives can extend to entities generally thought not worthy of punishment because they lack the necessary mental states and capacities."

Benforado believes the work will not only impact our current judicial system but will also add to the understanding of a long history of punishing nonhuman actors, principally animals.

"There are numerous examples of legal codes providing for animal punishment and records of actual trials over the centuries for attacking dogs, ravenous pigs and goring oxen," he says. "Many explanations have been offered for these seemingly strange practices, and I think our research offers a new scientific perspective on something that has puzzled people for hundreds of years."

#### INTERSECTIONS OF INJUSTICE

Although his research is aimed primarily at legal academics and psychologists, Benforado is also reaching out to a broad audience in a book, which will examine the criminal justice system through the lens of psychology and neuroscience. The book, called *"Unfair: How Our Hidden Minds Lead to Injustice,"* is slated for publication in late 2013 or 2014.

"The book is about the characters in our criminal justice system, what moves them, how they think and how bad outcomes can arise," he says. "We have a lot of assumptions about what is going on that are not supported by the evidence from psychology and neuroscience. Each chapter looks at a different character: the judge, the prosecutor, the police officer, the expert witness, et cetera."

"Consider our common sense assumptions about judges. We have an idea that there are two kinds of judges in the world: umpires, who just call balls and strikes, and activists, people with agendas. In the book, I unpack evidence from the mind sciences to see if this conception is accurate. And it turns out, it's not."

"All judges are susceptible to various cognitive biases and processes operating beyond their conscious awareness that may sway them one way or another. Little things like the time of day when a judge hears a parole case may have a huge influence," Benforado adds. "Researchers, for example, recently looked at over a thousand parole decisions and found that first thing in the morning the chance of parole was around 65 percent, but that it dropped to around 0 percent right before a break for a meal. After the break, it shot back up to about 67 percent. That's not the idea of how our legal system works. No one thinks it happens, or should happen, but when you actually look at the evidence it turns out that these sources of unfairness are having a big impact."

And so is Benforado. A history major at Yale, he first became interested in the intersection of psychology and the justice system while at Harvard Law School, where he earned his JD.

"I'm a firm believer that interdisciplinary work is the future of academia," he says. "The categories of these different departments that are so separate within universities, that's going to make less and less sense over time. The scholars who are willing and have the courage to reach across the divide into that other department across the university, I think that's where a lot of the breakthroughs are going to come."

*Benforado believes the work will not only impact our current judicial system but will also add to the understanding of a long history of punishing nonhuman actors, principally animals.*









**\_SUPER FILTER**  
Just one freshwater mussel is capable of filtering up to 20 gallons of water per day, making them crucial to ecosystem health.



*\_by Tim Hyland / photographs by Roger Thomas,  
Sylvan Klein and Danielle Kreeger*



# the underdogs

FRESHWATER MUSSELS GET LITTLE RESPECT AND EVEN LESS ATTENTION, BUT TWO DREXEL RESEARCHERS BELIEVE THESE 'UNDERDOG' SPECIES MIGHT HOLD THE KEY TO THE LONG-TERM REVITALIZATION OF THE DELAWARE RIVER AND ITS TRIBUTARIES.

**I**N THE CHESAPEAKE Bay region, state and federal authorities have spent hundreds of millions of dollars to replenish the bay's once-bountiful oyster populations.

Residents who live along the bay or on its many tributaries happily hang "oyster barrels"—essentially, makeshift oyster gardens—from their docks. Environmentalists speak passionately about the need to bring back the bay's once-massive oyster bars—bars so huge, it is often said, that ships could run aground on them. And Chesapeake Bay watermen, who so often find themselves at odds with the environmentalists, talk nostalgically about how great things *used* to be on the bay, back when the oysters were thriving.

The deep and abiding love for the oyster down in Maryland and Virginia has little to do with culinary taste. Rather, so many different people with so many different interests pine for the return of the oyster because they know that, at the end of the day, few things could ever do more to improve the bay's overall water quality—and, by extension, its overall value to the region—than a widespread

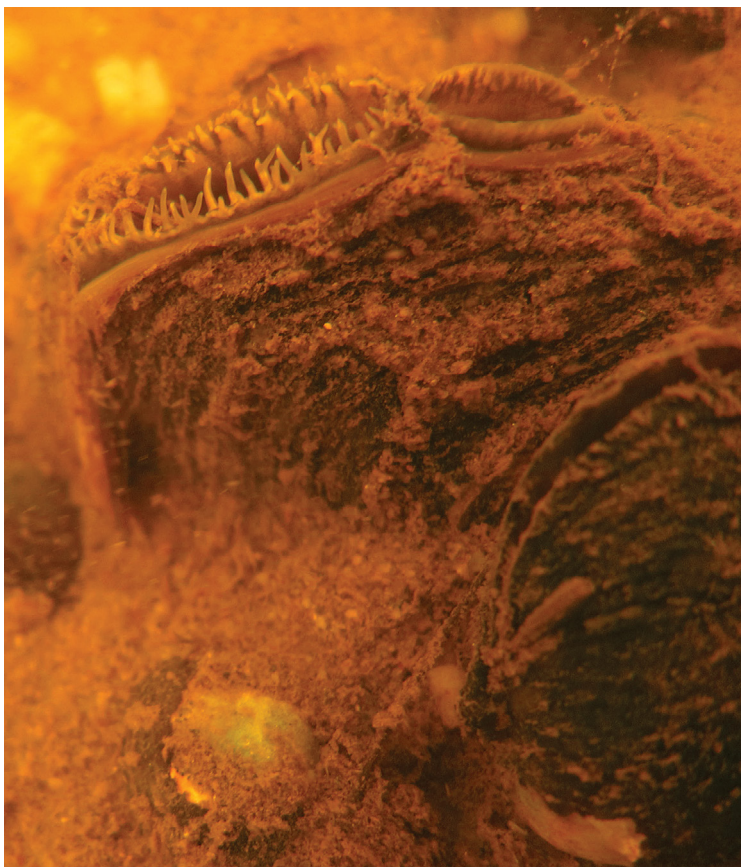
oyster revival. Just a single oyster is capable of filtering as much as a staggering 50 gallons of water a day, which means the tiny, unassuming oyster is nothing short of Mother Nature's perfect little water treatment plant. Given the oyster's remarkable ability to clean up fouled waters, then, it's easy to see why everyone in bay country is so completely united in restoring them.

Travel a few hundred miles north, however, and you're unlikely to find any such passion for the oyster's ugly step-cousin—the freshwater mussel. Which, in Danielle Kreeger's mind, is a great injustice.

Because just as the oyster may well hold the key to the bay's ultimate recovery, says Kreeger, so, too, do mussels hold vast potential to bring the freshwater river systems of the Delaware Estuary, including the troubled Delaware River, a huge step closer to their once-pristine states.

"They're the ultimate underdogs," says Kreeger, a research scientist at the Academy of Natural Sciences of Drexel University and and research associate professor in Drexel's new







## \_hope for the Delaware

On a recent expedition to a stretch of the Delaware River in lower Bucks County, Drexel researchers discovered seven different species of freshwater mussels in the area. The discovery was a promising one, given that at least two of those species were believed to be extinct in the area.

biodiversity, earth and environmental science (BEES) department, who has spent the past 15 years studying how a single mussel is capable of cleaning up to 20 gallons of water a day. “Very few people know anything about them. They get no respect. They have no eyes. They’ve got no charisma. They look like rocks. But when you see them in a tank, doing their thing, it’s like, ‘Whoa!’”

### CANARIES IN THE COAL MINE

The “thing” of which Kreeger speaks, of course, is filtering water.

Though they can’t quite compete with oysters in this department, mussels are still a hugely important natural water filter, with a single mussel capable of cleaning six gallons of water a day.

Where these mussels are plentiful (sadly, such areas are few and far between these days), the benefits to the wider ecosystem are enormous: By removing suspended solids and phytoplankton from the water, mussels can drastically improve water clarity, allowing light to more easily reach stream and river bottoms, thereby helping important underwater plants to thrive. At the same time, their waste serves as a natural fertilizer for those same plants.

Healthy mussel beds provide valuable habitat for any number of fish and other aquatic species, and help stabilize bottom sediments—no small issue for many urban waterways. They can even help remove dangerous pathogens from the rivers and streams in which they live.

“Where you find large populations of mussels, you find stable bank conditions, more stable substrates for other species, more habitat heterogeneity,” says Roger Thomas, co-principal investigator for the Academy’s Patrick Center of Environmental Research and member of Drexel’s new BEES department. “You have different elevations, little nooks and crannies for small fish and other animals to exploit. You get a greater variety of all species.”

There’s at least one other reason why mussels are important. According to Thomas and Kreeger, these species serve as canaries in the coal mine for freshwater ecosystems, providing scientists and environmentalists with a living gauge of water quality. On this point, scientists agree: The presence, diversity and overall population of mussels are important indicators of ecosystem health. When they are present, streams and rivers are healthier, more stable and more productive.



### ‘EVERY MUSSEL IS PRECIOUS’

Since 2007, the Partnership for the Delaware Estuary—for which Kreeger serves as science director—has been leading the Freshwater Mussel Recovery Program (FMRP), an initiative with the stated goal of

fostering greater conservation and restoration of native mussels through the Delaware Estuary watershed and the Mid-Atlantic region.

FMRP officials believe that by reintroducing and supporting the expansion of these native species, they can improve water quality and habitat complexity, remove pollutants before they move downstream to the Delaware and Chesapeake bays, save endangered or threatened species, and generally make targeted waterways healthier. And they believe all of this is possible even in rivers such as the Delaware, which faces such daunting challenges as ever-increasing water diversion in its northernmost

### A TOUGH LIFE

Young mussels rely on luck—and passing fish—to survive. But few are lucky: Out of a litter of thousands, only a handful will live to adulthood.

stretches (the river is a major supplier of water to New York City) and urban pollution as it flows through the cities of Philadelphia, Camden and Chester.

As part of this wider effort, Kreeger has been working with Thomas to document and more fully understand the state of mussels up and down the lower Delaware River, as well as its many tributaries, and identify which of these waterways might best support mussel repopulation in the years to come. And while both Kreeger and Thomas note that there is much work to be done, they say their recent work has turned up some promising signs for the oft-underestimated mussel.

In fact, a recent survey of the Delaware between Chester, Pa., and Trenton, N.J., revealed that the river is still home to seven different species of mussels, including two



## \_the amazing mussel

Freshwater mussels once numbered in the millions even in the smaller tributaries of the Delaware River. Today, they are showing small signs of revival after years of decline. Here, explore the freshwater mussel—an underappreciated but hugely important species for rivers throughout the Mid-Atlantic.



### \_THEY'RE GLOBAL

Mussels live on every continent on Earth, with the exception of Antarctica. There are 800 known species, and the U.S. is home to 300 of them.

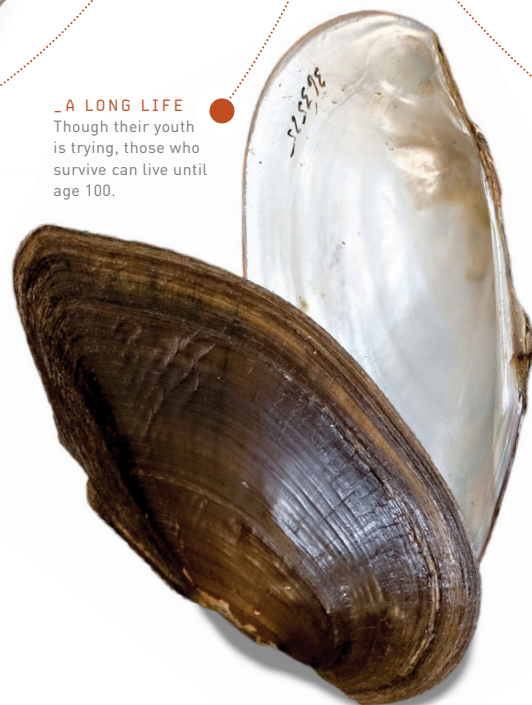
### \_MOBILITY

Mussels can move if necessary thanks to a "foot" that extends outside their shell.



### \_A LONG LIFE

Though their youth is trying, those who survive can live until age 100.



### \_GOING FISHING

Female mussels expel their young in hopes of attaching them to passing fish. The young mussels remain there for several weeks before dropping off and beginning life as adults.



### \_ONLINE

For more photos from the Delaware River expedition, visit [EXELmagazine.org](http://EXELmagazine.org)



**THE PEARL RUSH**

Millions of mussels in the Mississippi River were harvested in the 1800s, as people scrambled to find pearls inside. They were also harvested to make buttons.

**THREATENED**

It is estimated that 70 percent of all mussel species in the United States are teetering on collapse.

**AN IMPORTANT IMMUNITY**

Some mussel species are known to be completely cancer-resistant, and researchers believe the immunity could hold the key to better fighting the disease in humans.



that were believed to be extinct in the region. This is in stark contrast to smaller streams which are lucky if they have only one species. The survey, Kreeger and Thomas say, offers hope that some mussels survived and might be more resilient than previously believed. Not only that, but a big comeback might now be possible since water quality and general ecosystem health is generally improving in the area.

For instance, Kreeger notes that even modest efforts to protect these species weren't put into place until very recently. The idea that those small measures may already be making an impact for a species that struggles to replenish itself quickly—mussel reproduction, it seems, is a pretty complicated process—is an exciting one.

"Up until just a few years ago, these things were allowed to be taken for bait," Kreeger says. "We had to press on that for a while. To me, every freshwater mussel is precious. Ten years ago, people were very concerned about the conservation of the [endangered] species, but not about the others. Now that the story is coming out about the water-quality benefits, everyone realizes that every mussel is important."

Possibly as a result of this rising awareness, Kreeger adds, there is finally some momentum building behind freshwater mussel restoration.

During an outing on the northern reaches of the Delaware in mid-May, Kreeger and Thomas collected numerous different species, both male and female, then had one targeted species of the still-alive bivalves shipped immediately down to West Virginia. There, they would be delivered to a team of researchers who are working to perfect the art of mussel "farming," with the ultimate goal of being able to replenish entire beds en masse.

The method is still being worked on, and such efforts probably won't come to fruition for some time, but the researchers are hopeful that, someday, mussels will return in huge numbers to the Delaware. When that time comes, local residents will realize the importance of these freshwater underdogs.

"We talk about freshwater mussels sometimes and people who don't know about these things will say, 'Well, who cares? Why don't we focus on fish?'" Kreeger says. "But we consider mussels to be the ultimate driver of ecosystem-based restoration."



## \_INTERDISCIPLINARY, INSPIRING, AND FINALLY MOVING AHEAD.

Nearly five years after first being proposed, the **Drexel Smart House** project is finally moving forward. Students and faculty say its impact could be enormous. *\_by Maria Zanke*

**J**UST NORTH of campus, at 3425 Race Street in Powelton Village, sits a 19th century Victorian twin home, the stone-fortified former Pi Lambda Phi fraternity house that has sat vacant since the 1990s.

Thanks to a \$1.1 million pledge from the university, though, the long-languishing building—now dubbed the Drexel Smart House—has taken one step closer to becoming a full-fledged student residence, sustainable urban-living model and innovation classroom.

Exterior renovations on the building are set to begin in May, and project organizers have hopes of adding on an addition that would provide additional lab space and new meeting space as well. With a fluctuating group of students participating in the student organization-driven

project—anywhere from 12 to 25 in a given quarter—the Smart House concept is holding strong as it approaches its five-year anniversary.

“We’ve been planning for as much as we can,” says Kevin Malawski, current Smart House president and sixth-year architecture student. “We want students to be able to live and learn in the same place, but it’s more than that. Our student research is very applicable. We’re thinking about the long-term here.”

Since conception, the project has garnered volunteers from various Drexel disciplines, Powelton community support and input and nearly \$300,000 in grants from external organizations, including the Environmental Protection Agency.

“It was a perfect fit, to take this old, completely abandoned residence, and show if you can make this old Victorian sustainable, the same model can be applied to the rest of the neighborhood,” Malawski says.

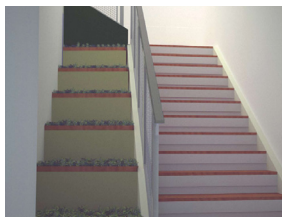
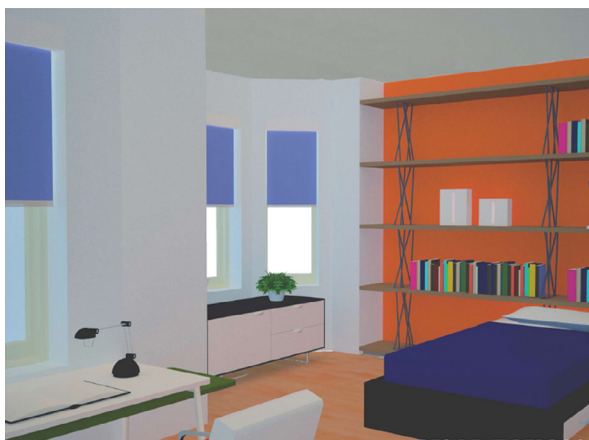
The vision for the Smart House project, a student-led, faculty-supported and multidisciplinary initiative, has been in the university’s peripheral since a student pitched the idea to Provost Mark Greenberg back in 2006.

“One of our challenges initially was, would there be the vitality to keep it going?” says LeBow College of Business professor and Smart House faculty adviser Joan Weiner, who was also involved in the early planning phases of the project. “President John Fry saw this as a very positive example of



## COLLABORATIVE EFFORT

The Smart House project will encourage collaboration across all disciplines, welcoming input from engineers, business leaders, architects, psychologists and others.



student initiative that truly had impact with its experiential learning component, the interdisciplinary component and the community engagement component.”

The Smart House aims to obtain the highest level of Leadership in Energy and Environmental Design (LEED) certification, setting precedent for future construction projects in the area.

“This project allows us to come around in our own way and do it together as students, delving into these deep issues and putting sustainability in the forefront of our mission,” Malawski says.

One way they hope to do so is by implementing a “green roof,” covering the structure with a waterproof white membrane and then with vegetation. Currently,





#### GREENER\_THAN\_GREEN

Smart House project leaders say they are aiming through their design to achieve the highest possible rating under the Leadership in Energy and Environmental Design certification process. Including in their plans is a “green roof” that will be studied in hopes of one day inspiring a cost-effective household design.

the Smart House team is working to develop a 10 lbs.-per-square-foot model as opposed to the typical 30 lbs.-per-square-foot roof, which is too heavy for traditional Philadelphia homes.

“Once the green roof is fully in place, we want to monitor its performance and prove it can be successful on average houses,” Malawski says.

The green roof will help regulate the building’s temperature—maintaining heat in the winter and repelling warmth in the summer—while also helping to manage the city’s stormwater by reducing the building’s impervious coverage.

But Malawski says architecture students are not the only ones who can learn

something from developing the Smart House.

“We’ve been multidisciplinary from the beginning,” Malawski says. “It’s about engineers working with business professionals, business professionals working with architects, architects learning from psychologists who are interested in studying how people interact with the technology in the house. We

want to encourage mingling between the disciplines.”

While students are often transient in the immediate neighborhood, Malawski says house organizers have sought input, guidance and critique from some of the Powelton neighborhood’s permanent community members.

“We truly do need and value their input,” Malawski says.



## \_ 'GATEWAY' TO ABUSE?

**C**OULD ROUTINE prescriptions for teens—such as painkillers for post-surgery aches and pains—affect the way they misuse drugs later in life?

Researchers at the School of Public Health recently published a study in the first issue of the *Journal of Public Health Research* that sought to identify patterns in the misuse of illegal drugs among young adults who also mis-

use prescription drugs.

This study, led by Stephen Lankenau, an associate professor of Public Health, is the first to compare patterns of prescription and illegal drug use among high-risk young adults who already engage in the misuse of prescription drugs. The report could help drug treatment providers be aware of patterns of drug use in order to treat their clients more effectively.

# 596

The number of young adults interviewed in either New York or Los Angeles. They were asked questions about patterns of drug use initiation, prescription history, their patterns of misuse and more.

# 90

The number of days participants must have used drugs within to be eligible to participate in the study. Most of the young people chosen were first approached on the streets in public locations.

# 12 YRS

The age most of the participants were first prescribed stimulants such as Ritalin and Aderal, which first exposed them to the experience of feeling relief from the drugs.

## \_ UNANSWERED QUESTIONS



**\_ PAULA ZELANKO**  
Zelanko is a staff scientist at the Academy. Her research focuses on stable isotope geochemistry and analysis.

**I**T'S ALMOST a given in science: the attempt to answer one scientific question sparks other questions to pop up along the way. That was the scenario for Academy of Natural Sciences of Drexel University scientists Paula Zelanko and Nate Rice, who recently launched a study to measure levels of carbon and nitrogen in feathers of the osprey (*Pandion haliaetus*) from the Academy's collection to track changes in the environmental health of the Delaware Watershed.

Ospreys are excellent indicators of environmental health because of their place at the peak of the food chain. Feathers hold a unique signature of a bird's environment and diet—and their molting patterns can tell scientists even more. In the case of the osprey, however, the molting pattern is both highly unique and poorly documented scientifically, so it wasn't long after Zelanko and Rice began their work that they realized they had to first learn more about this particular bird's molting pattern before forging ahead.

"This study was originally focused on reconstructing changes in the Delaware Estuary over time by analyzing historic specimens of the osprey," Zelanko says.

## LIGHT\_AS\_A\_FEATHER

Ospreys use what is called the "Staffelmauser molt," or the replacement of feathers in waves or stages, which allows for constant mobility.





## MEDIA ARTS &amp; DESIGN

## LAW

## \_HEALING POWER OF LIGHT

## \_BEYOND THE MOCK TRIAL

"But, all the data analyzed has opened up a new path of research pertaining to Delaware Bay osprey molt patterns, a previously unexplored topic."

"Most birds molt completely in a single molt season, from the outer feathers to the inner feathers," says Rice. "But the osprey is molting in a pattern that is unlike any other bird in the New World."

The basic pattern of molt is known for ospreys, Zelanko says, but it is not well documented where feathers are grown. For instance, researchers don't know if the feathers arrive at the birds' breeding grounds or their wintering grounds. This knowledge is important in determining which feathers to sample, however, as Zelanko and Rice didn't want to sample feathers grown on wintering grounds not located in the Delaware region.

After determining the osprey's unique use of the Staffeldmauser molt, Zelanko and Rice can continue their original objective: to study the nutrient levels in osprey feathers to determine the Delaware Watershed's health.



## THE \_LONG\_FLIGHT

Large raptors like the osprey— active hunters and long-distance migrants— have complicated molt cycles because they can't afford to be grounded for any significant amount of time.

NURSING HOME residents with dementia who experience "sundowners syndrome"—agitated behavior toward the end of the day—may benefit from research in Drexel's Antoinette Westphal College of Media Arts & Design and College of Engineering.

Thanks to a series of recent grants, associate professor Eugenia Victoria Ellis, AIA, is leading a project that will evaluate the interior design of the fourth floor dementia unit of St. Francis Country House in Darby, Pa.



Ellis and her team, along with Appalachian Lighting Systems, will develop a proof-of-concept LED luminaire that will simulate the color and intensity of natural daylight throughout the day. The prototype will provide quality illumination for visual tasks, help synchronize biological rhythms for better health, cognitive ability and performance, and correlate lighting levels with seasonal variation. It is slated for installation at the St. Francis Country House later this year.

"If successful, then the daylight-matching LED luminaire could become a state-of-the-art light fixture that improves health outcomes

while reducing energy use for a variety of applications including the health care, commercial and manufacturing industries, as well as a lighting solution to support 'aging in place,'" Ellis says.

The aim of the lighting system is to mimic daylight using artificial light sources while ensuring that lighting levels and color temperature changes throughout the day are synchronized with natural cycles. Ellis says the combination of appropriate wavelength and timing is the most important factor



**\_EUGENIA VICTORIA ELLIS**  
Ellis is an associate professor in the Antoinette Westphal College of Media Arts & Design. She is dedicated to preserving and cultivating the natural and built environment.

in achieving the desired biological effect.

Ellis and her team hope to collect the data necessary to support FDA approval of the luminaire for future health care applications.



**\_KARL OKAMOTO**  
Okamoto is the director of the business and entrepreneurship law program and a professor in the Earle Mack School of Law.

KARL OKAMOTO, an Earle Mack School of Law expert in corporate, venture capital, private equity and securities law, and corporate finance, has developed a groundbreaking approach to teaching transactional lawyering—and it's gaining national and regional traction.

While generations of law students have sharpened their litigating skills in moot court and mock trial competitions, Transactional LawMeets, created by professor Okamoto, is the first of its kind that allows students of transactional law to practice their deal-making skills.

In February, five regional competitions were held across the country. In addition to the Mid-Atlantic Regional Meet hosted by Drexel in Philadelphia, other competitions were hosted by Western New England College School of Law in Springfield, Mass.; University of Georgia School of Law in Athens, Ga.; University of Missouri-Kansas City School of Law in Kansas City, Mo.; and UCLA Law School in Los Angeles.

Transactional LawMeets was conceived in 2010 by Okamoto, a law professor and director of Drexel's Business and Entrepreneurship Law Program, to put students' negotiating

skills to the test under the scrutiny of seasoned transactional lawyers who serve as judges. Interest in the meets has been so high that teams from many law schools were turned away in the first two years.

"Law schools struggle to provide 'hands on' learning for future transactional lawyers," Okamoto says.

"LawMeets provide a taste of real deal lawyering by exposing students to realistic transactional challenges and to expert deal lawyers."

At each level of competition, teams are judged by seasoned transactional lawyers. The National rounds will be judged by distinguished

*"LawMeets provide a taste of real deal lawyering by exposing students to realistic transactional challenges and to expert deal lawyers."*

*-Karl Okamoto, Earle Mack School of Law*

practitioners from premier law firms and corporate law departments from both Philadelphia and New York.

This year's competition required teams to negotiate an employment agreement for the CEO of a fictitious company. Teams represented either the CEO or the company that was wooing her. At the close of each meet, the judges demonstrated how they would have brokered the same deal that the students had just negotiated.

"Both students and our experts from practice have been very excited about the program," Okamoto says.



## \_WELCOME TO THE NEW JERSEY ZOO, AND THE DISTANT PAST.

Paleontologists have discovered an abundance of **marine fossils** at a dig site in Gloucester County, N.J., and Drexel scientists are creating detailed digital reconstructions of their Cretaceous findings.

A FOSSIL DIG site in Sewell, N.J., has yielded a large number of marine animal fossils from the Cretaceous period nearly 65 million years ago, and Drexel scientists are doing more than just excavating the site. They're recreating it.

Drexel paleontologist Ken Lacovara, an associate professor in the College of Arts and Sciences, says he and his students will be producing 3D models of the turtles, crocodilians, fish and other animals found at the Gloucester County site to create a "virtual zoo of Cretaceous New Jersey."

"Technology in paleontology hasn't changed in about

*"Technology in paleontology hasn't changed in about 150 years. We use shovels and pick-axes and burlap and plaster. It hasn't changed—until now."*

—Ken Lacovara, associate professor,  
College of Arts and Sciences

150 years," Lacovara says. "We use shovels and pick-axes and burlap and plaster. It hasn't changed—until right now."

The team's first digital reconstruction—a five-minute animation of *Thoracosaurus neocesariensis*, an ancient New Jersey crocodile—was constructed by compiling a skeleton, then the musculature and finally its flesh, coloring and outward appearance.

The reconstruction was designed by Drexel student Evan Boucher, who used his Drexel education and expertise in digital media to bring the crocodile back to life on a computer screen.

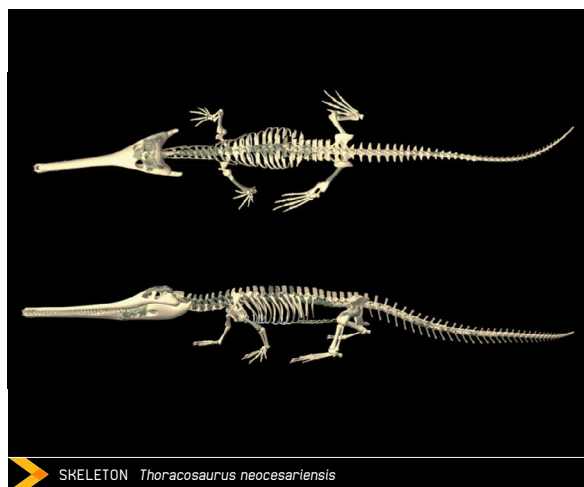
Boucher modeled the design after fossils discovered by Lacovara in New Jersey in late 2004. The fossils included "most of the spinal cord, a partial femur and partial humerus," Boucher says, "and pieces of the brain case, some teeth and a few pieces of the armored plates on the back."

The animation earned Boucher the John J. Lanzendorf Prize for the National Geographic Digital Modeling and Animation Award from the Society of Vertebrate Paleontology, which he accepted in November.

The site in Sewell offers the best exposed Cretaceous-age rocks between Spain and Montana. At the time of the extinction of the dinosaurs 65 million years ago, when these fossils formed, this location was underneath water, approximately 5 miles from the coast.

Their findings included a remarkable 3-foot-wide fossil of the extinct predatory marine turtle *Taphrosphys*, the largest fossil ever found of its species.

In addition to creating the virtual zoo, Lacovara is also teaming up with other Drexel professors to create 3D scans of giant dinosaur bones and fossils in his lab, a project that will allow them to test hypotheses about how dinosaurs and other prehistoric animals moved and lived in their environments.



SKELETON *Thoracosaurus neocesariensis*



SKIN *Thoracosaurus neocesariensis*



MUSCLES *Thoracosaurus neocesariensis*

## IN\_3D

Boucher, the student who created the digital recreation of the ancient crocodile, received a job offer at DreamWorks Animation, in part due to his work with the New Jersey fossils.



## BIODIVERSITY AND CONSERVATION

## \_ SNAKES ON THE BASE

Drexel researchers have discovered that an old Air Force base in the New Jersey Pinelands has become prime testing ground to study local species of snakes.

SOME OF THE snakes that slither throughout the Warren Grove Gunnery Range in Burlington County, N.J. are equipped with more than just the scales on their backs.

Twenty-two nonvenomous snakes and a small group of rattlers are now carrying transmitters, implanted by Drexel researchers from the Laboratory of Pinelands Research in the Center for Biodiversity and Conservation.

The researchers—including Walter Bien, director of the university's Laboratory of Pinelands Research—are tracking the snakes' movements using an antenna, studying the species among the 9,000 open acres on the gunnery range.

Students recently set up a fence around a runway to funnel snakes into culverts installed under the runway—a conservation experiment to see if snakes will use the culverts to cross under roads, where they are frequently killed by motorists. The lab is also studying which types of road surfaces make it easier for the snakes to cross the road safely.

The range is occupied by the Air Force, which is required by federal law to maintain the property. The New Jersey Air Guard, which runs the base, invited Bien and his colleagues to conduct research on the base, saving money for the guard and building a valuable relationship with Drexel.

Bien, a research professor of biology, is the principal investigator for field research being conducted at the Warren Grove Gunnery Range. He has conducted environmental experiments at the range since 2000.



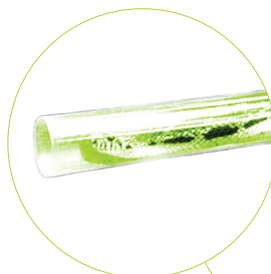
Drexel researchers have implanted as many as 22 snakes with transmitters used to track their whereabouts on the range.

9,000  
acres of land

The Warren Grove Gunnery Range in Burlington County, N.J. provides ideal space for Drexel's researchers to study snakes in their natural environment.



Bien and his students are experimenting with whether the snakes will use plastic tubes to cross a road, avoiding potential fatal encounters with motorists.







THE

FANTASY





ELLEN  
STAUROWSKY

Staurowsky is a professor of sport management in Goodwin College, with expertise in social justice issues in sport, athlete exploitation and college sport reform.

# AND THE HYPOCRISY

Ellen Staurowsky says it's time for the nation's universities to rethink the way college athletics are managed—and the way the money it generates is distributed. *by Mike Unger*

**I**N THE HEIGHT OF THE MADNESS this March, four college heavyweights descended on New Orleans for a basketball Mardi Gras.

At the NCAA men's Final Four in the Big Easy, thousands of fans shelled out big bucks to see the University of Louisville, the University of Kentucky, the University of Kansas, and Ohio State University compete for the national title in the Superdome. The three games were televised by CBS as part of the network's multibillion dollar rights agreement with the NCAA, and advertisers paid millions to hawk their products on the broadcast, seen in living rooms, dorms and bars around the world.

Yet in the midst of this parade of money, the players—18- to 22-year-old men who actually dribble, rebound and shoot—received no compensation. None at all. Therein lays the problem, says Ellen Staurowsky, professor of sport management in Drexel's Goodwin College School of Technology and Professional Studies.

Staurowsky is among America's foremost experts on the problems surrounding big-time collegiate men's basketball and football, many of which are detailed in "The Price of Poverty in Big Time College Sport," a jarring report she coauthored with the National College Players Association. It was released in November to much fanfare.

Cinderella might not have made it to this year's Final Four ball, but Staurowsky believes there's plenty of fantasy—and hypocrisy—in college athletics.

"There are some mythologies that are in operation within the business that do not always serve the best interests of the athletes involved," she says. "For years and years and years, we've had people saying athletes don't have anything to complain about because they have a free ride, when in point of fact the creators of that formula well understood that it wasn't even minimally a free ride."

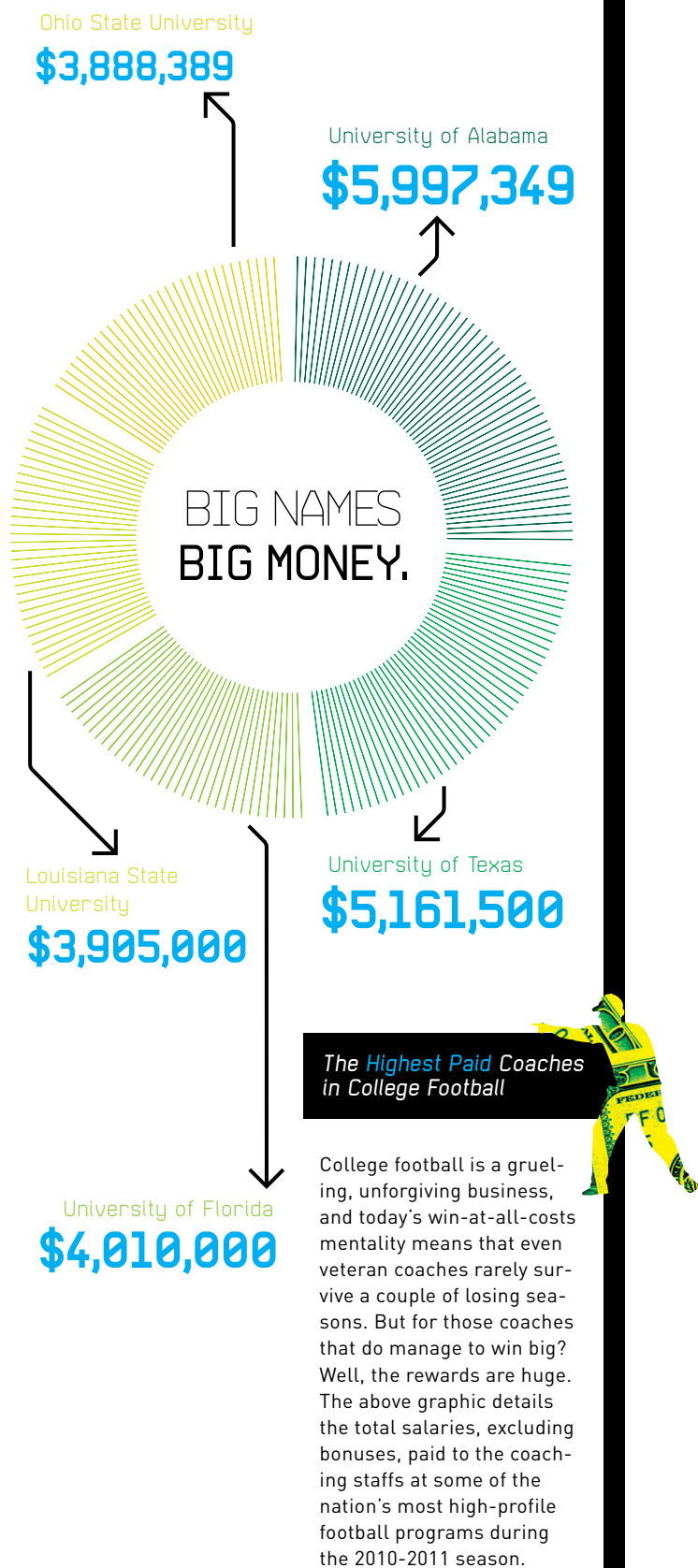
As "The Price of Poverty in Big Time College Sport," vividly explains, there is a gap in the value of a scholarship given to an athlete and the actual cost of attending college. That revelation has caused ripples in athletic departments across the country and has made waves on Capitol Hill, where U.S. Rep. Bobby Rush (D-Ill.) held a forum on the issue in November.

"The NCAA's constant mantra is, 'There's no way that college athletes will ever be paid,'" Staurowsky says. "I think that's an unfortunate stance to take from the standpoint that, in my view, it's a moral dilemma in terms of higher educational entities not affording employee rights simply because they've been permitted to exploit workers the way that they have."

## SPREAD THIN

Staurowsky says student-athletes in the revenue-producing sports can dedicate upward of 40 hours a week to their sport, leaving no time for a job let alone full concentration on their studies.





## THE GAP

Staurowsky played field hockey, lacrosse, softball and badminton as an undergraduate at Ursinus College. She has worked as a collegiate coach, athletic administrator and professor for more than 30 years, so she has not arrived at her opinions on college sports hastily.

Prior to coming to Drexel, she spent nearly 20 years as a tenured faculty member at Ithaca College, where she taught a graduate-level course in intercollegiate athletics administration. It was through that class that she first collaborated with Ramogi Huma, president of the National College Players Association.

"The Price of Poverty in Big Time College Sport" is the third report the two have released.

"Our original project was this notion of a quote unquote free ride for an athletic scholarship," she says. "There is misunderstanding among the athletes who receive those scholarships as well as within the general population at large about what a full athletic scholarship actually covers. From the 1950s to the present, the athletic scholarship has included tuition, room, board and books. There is in that calculation a gap between what the full cost of attendance is versus what a full athletic scholarship actually covers."

The gulf can be crippling to a student from a poor background or even one from a middle-class family.

"Our purpose was to simply explain that to people," Staurowsky says. "What that entailed was going into the United

States Department of Education database to which college and universities report what their tuition costs are each year along with what their expected costs are going to be associated with housing, room and board. Then, we provided an overview showing what the shortfall was between what an athlete would receive versus what the full cost of attendance was at that particular school."

They found that the average scholarship shortfall (out-of-pocket expenses) for

individuals classified as full-scholarship athletes was approximately \$3,222 per player during the 2010-11 school year. The room and board provisions in a full scholarship leave 85 percent of players living on campus and 86 percent of players living off campus below the federal poverty line.

"Cost of attendance includes all of those other expenses associated with going to college that do not fall into a specific billable category," Staurowsky says. "Any of us who has gone to college knows that we need money for transportation, if we want to go out to dinner on a Friday night to hang out with our friends, those kinds of basic expenses."

Too often, athletes can't afford them.

"There's a case now involving an athlete who 20 minutes before the NCAA Tournament was told that he could not compete," she says. "Jamar Samuels from Kansas State [was disqualified after] his AAU coach had given him \$200 in grocery money just so his family could eat. For an athlete like that who's coming through the system, it is entirely possible that if they're coming

*"You've got bowls that have had financial windfalls, you've had coaches and the decision makers who have been benefitting from this. It's the athlete who can't read, who's been declared ineligible because they accepted \$200 in grocery money, it's that kind of thing that I think has taken hold with a larger group of Americans who have said it's just not right."*



from a level of poverty that's so extreme that they literally do not have food on the table, that gap between what the scholarship covers and the full cost of attendance can feel like a mountain."

Stories like Samuels' strike a nerve in people, and Staurowsky's heard from fans, media and athletic administrators following the report's release. She's written opinion pieces on the subject for the *Atlantic*, *ESPN.com*, and the *Huffington Post*, and routinely speaks at universities around the country.

"I think there is kind of a mass effect that is growing right now," she says. "It's good from the standpoint that people are beginning to really grasp the magnitude of the inequities that exist. That was one of the things we were trying to show with our analysis. You've got bowls that have had financial windfalls, you've had coaches and the decision makers who have been benefiting from this. It's the athlete who can't read, who's been declared ineligible because they accepted \$200 in grocery money, it's that kind of thing that I think has taken hold with a larger group of Americans who have said it's just not right."

#### WHAT'S AN ATHLETE WORTH?

Staurowsky and her co-worker Ramogi Huma wanted to give people a sense of scale in terms of the value of a football or men's basketball player in relation to the amount of money generated by those sports.

Using the same revenue-sharing formula employed by the NFL and NBA, the report found the fair market value of the average Football Bowl Subdivision player and Division I basketball player was \$121,048 and \$265,027, respectively. At the University of Texas, football players' fair market value was \$513,922, but they lived \$778 below the federal poverty line and had a \$3,624 scholarship shortfall.

Duke basketball players were valued at more than \$1 million while living just \$732 above the poverty line with a scholarship shortfall of \$1,995. The University of Florida had the highest combined football and basketball revenues while its football and basketball players' scholarships left them living \$2,250 below the federal poverty line and with a \$3,190 scholarship shortfall.

"There's a power differential here that is really important to consider," Staurowsky says. "During the same period of time that the athletic scholarship has remained constant in terms of the formula, coach salaries have risen at a rate of 750 percent during the past 20 years, according to an economist at Duke. You can ask, 'Why did that happen?' It's not surprising that during the same period those coach contracts have become more complicated, we've also had a proliferation in the number of agents who are representing coaches in those negotiations."

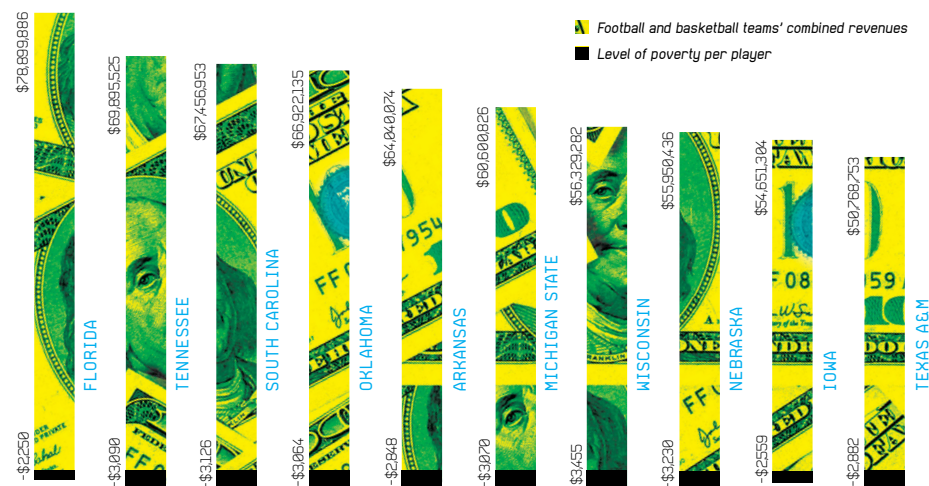
"If you have a coach whose bonus structure is greater than what the scholarship gap is for an entire football team with 85 full scholarships, that by itself speaks to this level of inequity that really has to be re-examined, especially when you've had a system that has intentionally denied the opportunity for athletes to negotiate for themselves. On one hand, we have athletes who are limited in terms of the kind of advice they can get when they're signing their national letter of intent—and they're expressly prohibited from having agents. On the other hand, we have coaches whose contracts have been growing and growing, and they get that kind of advice."

#### CHANGING LANDSCAPE

In the last year alone the NCAA has debated adding a \$2,000 stipend to scholarships (making them four-year deals instead of renewable one-year agreements), has seen massive conference

#### FAME, BUT NO FORTUNE.

In big-time college sports, fame is often the extent of the players' slice of the pie. Findings presented in Staurowsky's report "The Price of Poverty in Big Time College Sport" show that the nation's richest collegiate teams—which were calculated by combining football and basketball revenues of \$30 million or more in 2009-10—are comprised of players living, on average, well below the poverty line. Players who live on campus among these top 10 most-profitable teams live an average of \$2,957 below the poverty level—despite being the driving force behind some of the most profitable franchises in college sports.



realignment and has moved closer toward a football playoff.

It all begs the question: what's next?

"Given the way that the superconferences are going, I don't think it would be a bad thing for a separation of powers at this point," Staurowsky says. "I think the superpowers need to go, and when they go, they need to provide for player advocacy in a way that does not exist now. We don't need to fear what's going to happen with the rest of the system. I think the rest of the system may be poorer, but what will happen is we will actually have a model of amateur sport."

In a forthcoming article in the *Marquette Law Review*, in the media, and in classrooms across America, Staurowsky advocates a fair shake for Division I men's basketball and football players.

"I think it's a larger problem than simply saying, 'Well, make it a free education and that ought to be enough,'" she says.

"Freedom ain't free. It would be one thing if in this calculation we had 100 percent of students graduating, but the plain fact of the matter is that in the revenue-producing sports we have athletes who have been graduating at rates of 48, 50, 56 percent, which means there has not been a delivery on that promise for a very long period of time."

"There need to be advocates who can speak up on behalf of athletes who, right now, are in a very vulnerable situation," she says. "They risk the potential of either not being played, losing playing time, or potentially losing their scholarship. They don't have an advocacy group, they don't have any kind of labor group that will intervene on their behalf. There needs to be a leveling of the playing field in my view in terms of the power structure to give more opportunities for athletes to exert a voice without risking their careers."

*"I think the superpowers need to go, and when they go, they need to provide for player advocacy in a way that does not exist now."*



Some say the **Marcellus Shale** formation could be an economic and environmental panacea for Pennsylvania. Others are convinced shale drilling poses environmental risks. At Drexel, researchers are working across all disciplines to find the truth about the shale, and the natural gas locked beneath it.

*\_by Maria Zanke / photographs by Tommy Leonard*

A group of Drexel students, faculty and alumni traveled to a Marcellus Shale drilling site in mid-April to learn more about the drilling process.







# DIGGING DEEP

THE ROCK THAT lies more than a mile beneath much of Pennsylvania's isolated and idyllic countryside has been thrust to the forefront of national debate. And for good reason: Some scientists have said that drilling the Marcellus Shale, a rock formation densely permeated with natural gas, could spur Pennsylvania's very own gold rush.

"The Marcellus Shale is not just a little gas cap here or there," says Joseph Martin, a professor in Drexel's College of Engineering's civil, architectural and environmental engineering department who has observed Marcellus drilling sites first-hand, most recently at a site in Washington county on the western side of the state. "This rock underlies the entire Allegheny Plateau—probably 50 to 70 percent of Pennsylvania. So when they say Pennsylvania could be the Saudi Arabia of natural gas, they're not exaggerating."

That amount of fuel could provide numerous benefits to the region: a local source of energy, jobs in everything from production to surveillance and royalties for landowners in areas from which gas is procured. There are environmental benefits, too. Natural gas produces only 40 percent as much carbon dioxide and other greenhouse gases as coal, Martin says, and it can be burned to generate electricity, or compressed and liquefied for use in construction.

"Here in the state, there are 12 million people, and there are somewhere around 6 million occupied buildings," Martin says. "Every one of them has a combustor in the basement. If we replace all the coal burning with natural gas, all of our targets would be met."

So why do so many citizens, environmental activists, politicians and journals have so many qualms over what seems to be, on the surface, an environmental and economic panacea?

Well, the answer is simple: The procurement process for getting that natural gas out of the shale is so young that researchers and regulators haven't been able to catch up to the drilling that is already underway—and important questions about the safety of the process remain unanswered.

Because of the potentially adverse effects shale drilling could have on the region's drinking water, air land and infrastructure if not done properly, scientists and lawyers at Drexel



and beyond are scrambling to ensure that drilling the nearly 3,000 sites already in place—and obtaining new, cleaner energy in the process—will not come at the cost of local communities and their environments.

#### INNOVATION IN DRILLING

A typical Marcellus drilling site covers nearly a mile, topped with a six-acre, aboveground pad station where the drill is situated. To prepare a site, the surrounded land must be graded, retention ponds for the “fracking water” must be built and often-smallish country roads must be fortified to accommodate the influx of heavy equipment being transported.

“At this point in the process, it’s just standard civil engineering,” Martin says.

Even the next two steps in the process—directional drilling and hydraulic fracking, also known as “hydrofracking” or simply “fracking”—are techniques that have been in use for a few decades. The innovation in drilling the Marcellus Shale is the combining of the two techniques, with the intent of first releasing and then capturing the natural gas, Martin says.

Directional drilling is the process of drilling a mile into the ground while slowly angling the rig to eventually bore a tunnel a mile horizontally, creating a series of eight to 10 wells. In intervals, explosives are inserted to open the area for hydrofracking.

“They’re spreading the drill through layers of shale,” Martin says. “It’s like drilling through the center of a horizontal piece of plywood.”

Next, specialty firms such as Halliburton come onto the site

of Marcellus, N.Y., where the shale is exposed above ground, could last as long as 60 years.

“The Marcellus Shale is the easiest one to drill,” Martin added. “Should they keep drilling, they’ll have these pads and infrastructure, and in 20 years when wells begin to deplete, we’ll have the resources already in place to go back and drill the Utica and Upper Devonian shale formations. If we continue to develop technology, it could be even easier. And I happen to work for Drexel University in the College of Engineering, and we will find the technology. This is revolutionary.”

#### SALTWATER & EARTHQUAKES

The natural gas trapped in the Marcellus Shale is the result of sea animals decaying from a period when the stretch of land was underwater. As it turns out, the shale was an inlet sea that was eventually closed off and isolated, says David Velinsky, the director of the environmental biogeochemistry section of the Patrick Center for Environmental Research, a department within the Academy of Natural Sciences of Drexel University.

As a result, Velinsky says, the Marcellus Shale that formed is incredibly dense with salt—and that’s part of the problem.

“When you put the fracking water down there and it interacts with the shale, the water comes back up with a concentration of salt [that is considerably higher than that of] sea water,” Velinsky says, adding that the salinity of fracking flowback water is nearly 80 parts per thousand—more than double the typical 35 parts per thousand of ocean water.

Of the 4 million gallons of water used to hydrofrack at a given site, typically at least 3 million gallons is ejected from the ground, Martin says. Essentially, this leftover brine, known as “flowback,” is a waste product.

In areas of Texas and Ohio, drillers have been able to inject



#### MARCELLUS\_SHALE

The Marcellus Shale is a sedimentary formation that underlies most of Pennsylvania and West Virginia, extending into parts of Virginia, Maryland, New York and Ohio. It is one of a handful of gas reserves in the U.S. and is one of the largest natural gas formations in the world.

## HYDRAULIC\_FRACKING :

The process of producing fractures in a rock formation that stimulate the flow of natural gas or oil, increasing the volumes that can be recovered. Fractures are created by pumping large quantities of fluids at high pressure down a wellbore and into the target rock formation. (Source: EPA)

to inject as many as 4 million gallons of water mixture at an extremely high pressure. The mixture generally consists of fresh water, sand and chemicals that act as viscosity reducers, allowing the natural gas to escape and flow efficiently into the recovery wells.

“The high-pressure water is what fractures the sand,” Martin says. “It’s like the sand holds the door open, and the chemicals keep the door propped like a door stop to keep the gas flowing into the wells.”

Each well is lined with five casing strings that gradually get smaller as they get closer the shale. Each string is fully cemented to the surface with more than 3 million pounds of steel and cement, ensuring the gas does not leak and remains securely in the well.

“The most important innovation that’s happened was the creation of the electronics to monitor where the gas is,” Martin says. “The development of sensors and software to measure microseismic events has made accessing these incredible resources possible.”

Martin estimates the reserves of natural gas that lie within the Marcellus Shale, which was named for the small town

the flowback water into two-mile deep aquifers.

“That geologic situation is not available in Pennsylvania, though,” Martin says. “There aren’t any empty sandstorm layers underground for them to inject it in.”

Currently, Pennsylvania drillers reuse the flowback water to hydrofrack other local sites, then eventually ship the unusable flowback to be injected in out-of-state aquifers—a solution that has already proven to be somewhat unreliable, if not downright dangerous.

On December 31, 2011, a minor earthquake—it actually registered a 4.0 on the Richter scale—rattled the small city of Youngstown, Ohio. Some scientists believe the seismic activity was induced by the high concentration of flowback disposal aquifers in the area, Martin says.

“If they had to, they could simply evaporate it,” Martin says. “That would just give you salt, which would be a solid waste you could take to a landfill. That’s a solution—but it’s an expensive one.”



The drill is typically situated on a six-acre, aboveground pad, which sits in the center of a mile-wide area. There are currently more than 3,000 sites.





Drexel researchers working across several fields say that many important questions about Marcellus Shale drilling remain unanswered.





Velinsky says companies such as General Electric have experimented with portable, tractor trailer-sized treating devices and reverse osmosis but added that such solutions are both pricey and energy intensive. It's easier, if not safer, to stick with the established techniques.

"The salts themselves are very difficult to treat," Velinsky says. "When you have this water that is basically a pond of salt, the only other way to deal with it other than evaporation would be to dilute it down, adding more water."

While a waste management system that is both inexpensive and environmentally friendly has yet to be developed in Pennsylvania, some scientists like Charles Haas, the College of Engineering's civil, architectural and environmental engineering department head, say drillers have more to worry about than the salt in the fracking fluids.

A lot more, actually.

#### CONTAMINATION CONCERNS

"One of the misconceptions is that the water produced after drilling is just salty," Haas says. "In addition to the high concentration of salt, it has a number of other inorganic elements to it—some radioactivity, and some residuals from the original fracking fluid itself."

Haas says the chemicals used during fracking vary from firm to firm and depend on the particular site's geology and chemical makeup. Currently, companies' fracking fluids are protected by law as a trade secret, and therefore, the firms are not required to disclose their formulas.

"There have been lists put out there—a variety of organic

"At this point, we really just don't know," Haas added. "All we have is some anecdotal information."

Some scientists are stepping up to back these anecdotes with data.

In July 2010, Velinsky and his Patrick Center colleagues studied nine headwater streams surrounding or within Susquehanna County, focusing specifically on comparing surface water.

"We saw all the discussion about Marcellus happening, [and] the staff and scientists came together and decided we needed to study this," Velinsky says. "This is too big to ignore. This isn't a one-time thing like the BP oil spill. This is something that could potentially impact Pennsylvania for a long time."

The research team compared sites that were similar in watershed and physical stream characteristics, but differed in the density of natural gas wells in their region.

"We want to be able to give regulators a threshold of well density in a given area," Velinsky says. "We're trying to figure out what is a reasonable amount of drilling in a watershed before you start to see an impact."

The Academy report showed there was a significant correlation between increases in natural gas well density with decreases in water quality indicators, such as the types and number of macroinvertebrates, algae, rocks and salamanders, despite the small sample sizes.

"Though the study was preliminary, it was enough to say, 'OK. We should probably do a bigger study,'" Velinsky says.

"This is a moving target," Velinsky says. "There might have been five wells in a given area last year, but there may be 12 this year. We'll see what the differences are. For areas like the Delaware River Basin, one of two water sources for Philadelphia, where there isn't any significant drilling yet, we'll be analyzing background samples chemistry-wise, so that when drilling does start up, we'll have something to compare it to."

*"We saw all the discussion about Marcellus happening, [and] the staff and scientists came together and decided we needed to study this. This is too big to ignore. This is something that could potentially impact Pennsylvania for a long time."*

compounds, hydrocarbons, various solvents—but that's part of the controversy," Haas says. "The level of monitoring is very poor."

In Pavillion, Wyo., the Environmental Protection Agency sampled water from nearly 20 of the town's 80 wells after residents reported high levels of water pollutants, alleging their water turned black and smelled like gasoline. The EPA detected high levels of several petroleum hydrocarbons, including benzene and methane, though it was uncertain as to whether those found in the groundwater had the potential to migrate to drinking water aquifers.

Though the report was uncertain as to whether hydrofracking was the cause for the appearance of these compounds, some Pennsylvanians fear their water could also be at risk of contamination if Marcellus continues to be drilled.

"If the well is not adequately constructed and adequately drilled, you can get a cross connection between the well pipe going into the gas field and the drinking water aquifers that lie above it," Haas says. "So you can get contamination between the drill fluid, the fracking water that's used, the gas that's being released and the individual aquifers."

#### AIR EMISSIONS

Pete DeCarlo, an assistant professor in the department of civil, architectural and environmental engineering, says there's yet another area in Marcellus research that is often overlooked as a potential environmental issue: air quality.

In fact, DeCarlo recently testified at a public hearing about air emissions from Marcellus operations, urging companies to acquire more data before increasing drilling activity.

"Without understanding the current baseline and monitoring that as drilling activity is increased, we're not going to get the full picture of the Marcellus drilling impact," DeCarlo says.

DeCarlo says the expected air pollutants from drilling activities in the Marcellus Shale include Particle Matter (PM), Oxides of Nitrogen (NOx) and Volatile Organic Compounds (VOCs), adding that the latter two can react with sunlight in the atmosphere to form ground-level Ozone, a pollutant that is damaging to both human and plant health.



VOCs—which include methane, the key component of natural gas—are greenhouse gases that absorb infrared radiation, eventually “contributing to global climate change,” DeCarlo says.

“There are considerable uncertainties in the magnitude of fugitive emissions from wells and natural gas infrastructure, and this is an area of research and debate in the scientific arena,” DeCarlo testified at the Feb. 27 hearing. “Reduction of fugitive emissions of methane is a benefit to both natural gas extractors, as the loss of methane is a loss of revenue, and a benefit for the climate system.”

These pollutants can be emitted during various parts of the drilling operation.

“We know they exist, but the actual impact of those air emissions isn’t quite understood yet,” DeCarlo says.

He added that one of the main reasons for that uncertainty is because the monitoring systems in place weren’t designed with situations like Marcellus in mind.

“In general, air quality monitoring tends to be measured in urban areas, big cities,” DeCarlo says. “Because Marcellus is so spread out, there aren’t a lot of monitors on a regional scale—and that’s a difficult thing to do.”

DeCarlo says some scientists are experimenting with non-traditional, low-cost monitoring systems, but added that those have tended not to be as accurate as the systems already in use.

Currently, Drexel does not take a position on the overall advantages or disadvantages of obtaining gas from the Marcellus Shale. DeCarlo says the role he and his colleagues play in con-

*“Because Marcellus is so spread out, there aren’t a lot of [air quality] monitors on a regional scale—and that’s a difficult thing to do.”*

tributing to the Marcellus Shale discussion is to help determine and make decisionmakers aware of drilling’s impacts.

“We encourage the efforts to perform the extraction, with the intent to minimize the impact on our air quality,” DeCarlo says. “[...] It’s for the policy makers to decide at what level that’s appropriate.”

#### THE GREAT UNKNOWN

A lack of substantial data has proven to be an obstacle not only for scientists, but for environmental regulators, as well.

Alex Geisinger, a professor at the Earle Mack School of Law, launched a practicum called Hydrofracking and the Clean Water Act, enabling students to explore a variety of legal issues embedded in natural gas extraction. Geisinger says since environmental laws are generally structured by medium, a starting point for environmental lawyers is to consider the exposure pathways.

In the case of Marcellus, where ground, air and drinking water are intertwined, the pathway is not entirely clear.

The lack of data is coupled with the fact that fracking is exempt from most major environmental laws at the federal level,

including the Resource Conservation Recovery Act and the Comprehensive Environmental Response, Compensation and Liability Act, known as Superfund, Geisinger says. One legal venue from which fracking is not entirely exempt, however, is the Clean Air Act. That’s because one of the main components of natural gas is benzene, which Geisinger says is a “relatively potent greenhouse gas.”

“Benzene is going to be released into the atmosphere when firms do exploratory drilling, and potentially when they do the actual drilling for production,” Geisinger says. “The EPA is hoping to control this process more at the federal level.”

Fracking may also be nonexempt from the Clean Water Act if the drilling pads prove to create runoff into streams and other surface water bodies that could ultimately find their way into the Chesapeake Bay, one of the most closely protected waters in the United States. Of course, the extent to which runoff occurs from the drilling sites remains unknown.

“If we find that there are sediment or other harmful materials present, they could eventually create serious problems,” Geisinger says. “But we just don’t know yet.”

That leaves the states to try to create a legislative framework, and without statistical proof the drilling process causes harm, the regulatory lines are blurred.

While some landowners fear regulatory action may not be able to catch up with damage that’s already under way, environmental lawyers are being careful not to act prematurely.

“There’s a concern within the legal community that we’re sort of letting things go as they’re happening without knowing what they’re going to cause,” Geisinger says.

Geisinger’s concerns are echoed by Haas, who says in addition to more active surveillance and mandates on companies’ financial resources to remediate damage caused along the way, drillers should be held accountable for restoring sites once their resources have been depleted.

“None of the sites have really finished their useful life yet,” Haas says. “But the environment needs to be restored after the site has closed. I think there’s an expectation that the drillers will be able to do that, but there’s no guarantee. We need an appropriate amount of compensation to the community for the diminishment of their surrounding environments.”

Geisinger says fracking companies do offer royalties to landowners whose properties are in some way affected by the drilling sites, and while they are appreciated among many beneficiaries, he added that some are claiming their property was undervalued and are filing claims to reassess what they are paid.

Still, experts such as Martin believe that in addition to providing relatively clean energy to Pennsylvania, drilling the Marcellus Shale could provide the financial relief that’s needed for families.

“Some people aren’t paying a bit of attention to the honest, hardworking people in the middle of the state, who would benefit from the royalties and jobs this drilling would bring,” Martin says. “There’s a lot of controversy surrounding this thing, but there’s not a lot of scientific basis for it. A lot of it is ideological. But in the meantime, we need to keep in mind, ‘How else are we going to find a green way to keep our houses warm?’”

#### \_ ONLINE

For more photos from the Marcellus Shale tour, visit [EXELmagazine.org](http://EXELmagazine.org)



Water used during fracking returns to the surface as highly saline brine water. This waste must be stored, reused or shipped away.





## \_BEAUTY IN A BOX

THE TITIAN R. Peale Butterfly and Moth Collection housed at The Academy of Natural Sciences of Drexel University is one of the oldest entomological collections in North America. Although only about 4,000 specimens, the Peale Collection forms a special part of the Academy's collection of four million specimens of insects because of its age, research data, technique and beauty.

Peale was an early North American naturalist, and the youngest son of the large family of artists and naturalists headed by Charles Willson Peale of Philadelphia. He was elected to membership to the Academy at the age of 18 in 1817.

His love of Lepidoptera (butterflies and moths) was reflected throughout his entire life. The earliest specimen dates from the 1820s when he was a young man in Philadelphia, where he first developed the "Peale Box." This unique type of box allowed him to view the specimens from above and below for study and illustration, yet protected them from insect pests, light and moisture, which destroyed other collections of this time. Several boxes date from 1885—his last year of life.

Peale added book covers to the boxes—a feature that protected the collection from light and allowed him to record abundant natural history information, which continues to enhance the work of researchers today. The collection documents beautiful insects from a variety of environments no longer available and includes many species that have since gone extinct or become extremely rare.





The Academy of Natural Sciences of Drexel University houses one of the oldest **entomological collections** in North America—and its method of preservation is as unique as the butterflies it protects.  
 \_photographs by Robert Clark / text prepared by Jon Gelhaus, curator, department of entomology

Collected by J.P. Peale in the vicinity of Philadelphia.

1. Chrysalis, of *Limenitis Disippus*
2. *Limenitis Disippus*
3. *Limenitis Disippus*.
4. *Papilio Glaucus*. ♀ — "Caterpillar fed on *Magnolia glau-*
5. *Papilio Glaucus* ♀ — "ca., near Camden. Changed to
6. Chrysalis of *Pap. Glaucus*. Chrys. July 21<sup>st</sup> 1833; — came out
7. *Thecla Augustus* Kirby. May 14<sup>th</sup> 1834.
8. *Thecla Niphon*? Boisd.
9. *Satyrus Slope*. 2.
10. *Satyrus Eurythris*. ♂ } *Oronymphala Eurythris*. Fab. (1775)
11. *Satyrus Eurythris* ♀ }
12. *Hipparchia*\* *semidea*. } Say Am. Ent. v. 3. no 5. The sp<sup>ies</sup> is the one
13. *Papilio Asterias*. ♂ } drawn for my friend J. Say. 1828.
14. *Papilio Asterias*. ♀
15. *Papilio Asterias* ♀ — Caterp<sup>r</sup> fed on Rue. changed July 13<sup>th</sup> —
16. Chrysalis of *P. Asterias*. ♀ } Came out on the 23<sup>rd</sup>. Drawing 18.
- 17

\* Now placed in the genus *Canonympha* Rub.

No 12 is Say's type of *Chionobas semidea* [H. Skinner]  
 This species does not occur in the vicinity of  
 Philadelphia [E. T. C. Jr.]

**BOX 1A**

This box includes a sampling of the butterflies occurring in the vicinity of Philadelphia in the early 1830s. The bottom glass was an important innovation—Peale used it to affix numbered corks to the glass for labeling specimens—because it allowed him to view the underside of the specimen without destroying the seal of the box. The corresponding book cover is labeled with the numbers and his identifications of the specimens and other biological information. Specimen 4, a dark form of the female Tiger Swallowtail butterfly, *Papilio glaucus*, was reared by Peale from a caterpillar collected in Camden, N.J., in 1833. Specimen 12 is the only surviving butterfly specimen studied by the "Father of American Entomology," Thomas Say, one of the original founders of the Academy. Peale illustrated the specimen for Say's *American Entomology* published in 1828.



Peale collected butterflies along the coast of Brazil, but it is not clear whether these specimens were from his collecting, or received from others. The book cover has a label marked "Prepared by T. R. Peale Museum Philadelphia," a reference to the Philadelphia Museum developed by his father in the late 1700s and run by family until 1840. Academy scientists believe this box may have been viewed by visitors to one of America's first museums.



Underside





Topside

**BOX 29**

The brilliant blue butterfly is a male *Morpho anaxibia*, known only from Brazil. The intense iridescent blue is caused by the structural properties of the wing scales, and varies from dark to blue depending on the angle of the light on the wing. This variable effect makes it hard for predators to follow the butterfly through the tropical forest.



## ENTOMOLOGY

This butterfly is *Anetia pantheratus clarescens*, the False Fritillary, a subspecies known only from Cuba and noted as rare on the island in the last 25 years. Although the specimen is not in a Peale Box, the label clearly indicates it is part of Peale's Collection at the Academy. After retirement from the U.S. Patent Office, Peale spent the last years of his life working in the Academy attempting to finish a large work called "Butterflies of North America," but could not find funding to complete it. His collection came to the Academy after his death.







**\_SPECIES**  
*Anetia pantheratus*  
*clarescens*



ENTOMOLOGY

\_BOX 2

This variety of butterflies, collected by Peale in the Philadelphia area in 1833, are mostly from the nymphalid group, pictured in the center row, and the pierid group, pictured on the two outer rows.

Specimen 15 is a notable non-butterfly specimen—a parasitic ichneumon wasp that emerged from one of the Painted Lady Butterfly caterpillars Peale was rearing.



Underside



Topside

\_BOX 7

Four specimens of the large Polyphemus Silk Moth, *Antheraea polyphemus*, with the cocoon of the species, are shown pinned between two of the moths, cut open to show the pupa inside.

Two of these specimens were illustrated by Peale, as he noted on the end plate book cover.



Underside



Topside





Underside



Topside

#### BOX 50

This box displays a variety of moths from Europe without further information on where they were collected or how Peale obtained them. Most prominent are the Underwing Moths of the genus *Catocala*, the three specimens (2, 8, 9) with brightly patterned hindwings of orange and black or blue and black. In Peale's time, specimens 3, 4 and 5—the species *Noctua pronuba*, the Yellow Underwing—was purely a European species; since its accidental introduction into Canada in the late 1970s, this species has spread rapidly throughout North America and is a common moth found at porch lights in the Philadelphia area.



Underside



Topside

#### BOX 11

Peale collected these butterflies when he was in his 70s, some from where he lived in the Holmesburg section of Philadelphia, and others from several beaches in New Jersey. Specimens 24 and 25, the Cabbage White, *Pieris rapae* were originally European pests to crucifer crops such as cabbage. It was accidentally introduced into Quebec in 1860 and New York in 1871, and yet already in 1874 Peale had collected it in Philadelphia, documenting how quickly this butterfly spread. The Cabbage White is now the most common butterfly in North America.





Underside





#### BOX 37

This collection of butterflies—the bottom of the glass pictured left, and the top of the glass pictured right—is from the “vicinity of Philadelphia” in 1831, collected by Peale.

Specimens 1 and 2 in the boxes represent the Regal Fritillary, *Speyeria idalia*, a beautiful butterfly not seen in Philadelphia for nearly a century. This butterfly, characteristic of meadows, is almost totally gone from Eastern North America, remaining in two isolated populations, although it is common still in the remaining prairies of the Central Plains.

Specimens 9 and 10 represent the Monarch Butterfly, *Danaus plexippus*, which migrates to Mexico and California in autumn to spend the winter. Although a common summer butterfly in the east, the Monarch Butterfly’s limited overwintering sites in Mexico are a concern for the long-term survival of this species.





\_SPECIES  
*Castnia pallasia*





Along with his obvious interest in butterflies and moths, Peale was also something of an avid photographer, and was in fact credited with inventing several early photography techniques. Curiously, Peale was not known to ever have photographed his specimens (except one surviving photograph of a moth), although his surviving photographs show many landscapes, people and buildings.

ONLINE

To see the extended photo gallery, visit [EXELmagazine.org](http://EXELmagazine.org)



## \_IN FOCUS: THE CENTER FOR SYSTEMATIC BIOLOGY AND EVOLUTION

**T**HE ACADEMY of Natural Sciences of Drexel University holds one of the world's top natural history collections. The collections are of international significance, comprised of more than 17 million plant and animal specimens from around the world, and serve as a library of the history of life on earth. Currently, a team of Academy researchers from the Center for Systematic Biology and Evolution are using a slice of that collection—the massive Botany collection—for a variety of research projects.



\_TATYANA LIVSHULTZ

Tatyana Livshultz, assistant curator of botany, studies the evolution of floral form and function. Her work focuses on the Apocynaceae, the milkweed and dogbane family—a group of about 5,000 species of flowering plants. One lineage, the milkweeds, has some of the most structurally complex flowers on Earth with remarkably efficient pollen transfer. Livshultz is using a variety of scientific approaches to understand where, when, why and how milkweed flowers got so efficient.





The Monnina genus comprises about 250 species, growing everywhere from very dry to very humid habitats. These plants have very diverse habits and fruit morphology. Since they serve as a fruit source for bees, ants and birds, Monnina is very important to its ecosystem as well. Though it is recognized that Monnina is ecologically and morphologically diverse, this diversity has not yet been explained. Alina Freire-Fierro, manager of the botany collection at the Academy, has traveled all over Central and South America to study the habits of this genus and is using molecular and morphological data to understand this biodiversity.



\_ALINA FREIRE-FIERRO



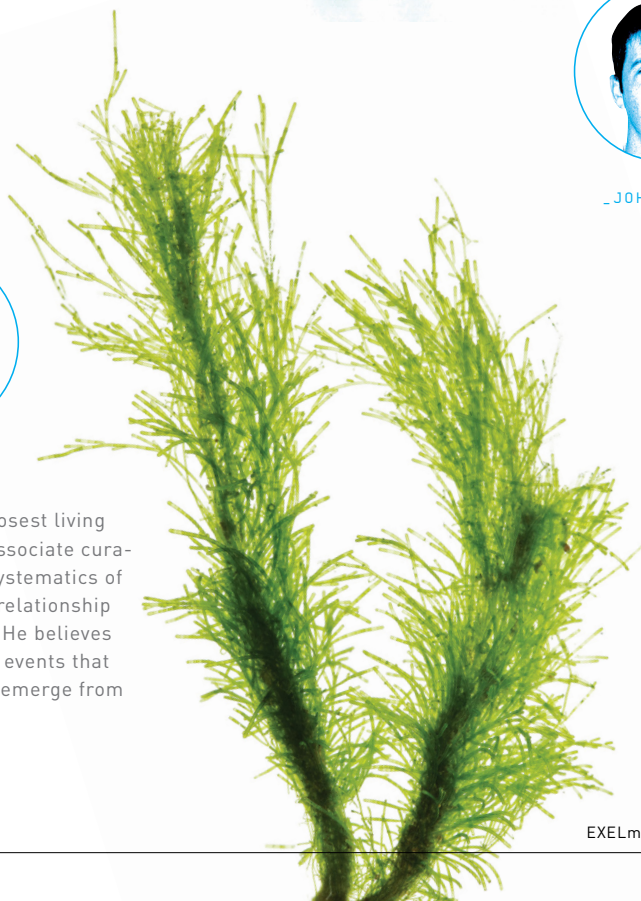
\_RICHARD MCCOURT

The green algae known as charophyte are the closest living relatives of land plants, and Richard McCourt, associate curator of botany, is researching the evolution and systematics of charophyte algae to understand the evolutionary relationship of these algae with other algae and land plants. He believes this can be done by discovering the evolutionary events that allowed the descendants of charophyte algae to emerge from their freshwater pond habitats onto land.

John Hall, postdoctoral research associate, also focuses on systematics of green algae, using molecular phylogenetic methods to study evolutionary relationships among charophyte algae. Hall is also interested in studying the biology and evolution of Zygnematophyceae, a species-rich lineage of freshwater organisms. Though thousands of species have been identified as belonging to this group, very few have been thoroughly examined in a molecular phylogenetic framework; since phylogenetic studies shed light on the origin and evolution of growth habit and developmental processes, this is an area of research that deserves intense focus.



\_JOHN HALL





## \_THE CLOCK IS TICKING

**D**REXEL PROFESSOR of biology James Spotila, a leading sea turtle expert, recently helped lead a study that could reduce deaths among endangered leatherback turtles.

Leatherbacks are the widest-ranging marine turtle species and are known to migrate across entire ocean basins. These long-distance migrations are likely to increase the risk that these animals may be caught in fishing gear, undermining conservation efforts to protect turtles on their nesting beaches. Interaction with fisheries is believed to be a major cause of death, which is of particular concern in the eastern Pacific Ocean, where the number of leatherback turtles has dropped by more than 90 percent since 1980.

"Leatherback turtles are long-lived animals that take a long time to reach maturity, so when they are killed in fishing gear it has a huge impact on the population," said Spotila. "Their numbers are declining so rapidly it



**\_JAMES SPOTILA**  
Spotila is the Betz chair professor of environmental science. He specializes in physiological, biophysical and conservation biology.

is critical that measures are taken quickly to ensure these animals don't go extinct."

Spotila and his colleagues used state-of-the-art satellite tracking, the largest satellite telemetry data set ever assembled for leatherbacks, to track 135 turtles. The study found that the western Pacific population traveled to many different feeding sites. This wide dispersal allows for a greater likelihood to find food. It also means that the turtles are more vulnerable to being caught unintentionally by fishing gear in coastal and offshore areas.

The eastern Pacific population had a very different migration pattern, traveling from their nesting sites in Mexico and Costa Rica to the southeast Pacific. These turtles tended to feed in offshore upwelling areas where their food, almost exclusively jellyfish, may be concentrated. The more limited feeding areas of the east Pacific turtles makes them more vulnerable to any changes that occur to the distribution or abundance of jellyfish. Deaths caused by human activities, such as being caught in fishing gear, also pose a greater risk of causing this population to go extinct because they have a smaller range than the western leatherbacks.

Said Helen Bailey of the University of Maryland, lead author of the study: "This information ... is essential for identifying hot spots and assessing where limiting fishing at particular times of year may be effective for protecting leatherbacks."

## MORE\_TROUBLES...

In late May, Spotila published another study about the leatherbacks, this one focusing on a new threat: Global warming. As temperatures warm, Spotila reported in the journal *PLoS ONE*, beaches may become so hot that turtle eggs may not survive.



## \_GREEN INFRASTRUCTURE

*Drexel's Franco Montalto is searching for better ways to deal with problematic urban stormwater.*

**F**RANCO MONTALTO says the "greening" of an urban area can do more for a city than just add aesthetic value. He says it can also provide solutions to major infrastructure problems, especially when it comes to dealing with excess water resulting from stormy weather.

"In a city like Philadelphia, you get a lot of runoff generated, and that gets into the sewer," says Montalto, a Drexel assistant professor of engineering. "That'll cause raw waste water to overflow into adjacent rivers and potentially also back up in people's basements. It's illegal, and we need a long-term solution for it."

Thanks to two grants from the National Science Foundation and partnerships with the Philadelphia Water Department and the New York City Department of Parks and Recreation, among others, Montalto is monitoring the impact of urban green infrastructure solutions implemented in Philadelphia and New York, and has even simulated scenarios should the cities continue to expand their green commitments.

Montalto notes that cities such as Chicago, Milwaukee and Portland have implemented multi-billion dollar underground tunnels and tanks to capture the excess runoff. But he says there's a more efficient—and less expensive—way to deal with excess water.

Philadelphia and New York City have, respectively, committed to retroactively greening about 40



**\_FRANCO MONTALTO**  
Montalto is an assistant professor of civil engineering, with research interests in the effects of built infrastructure on societal water needs, green design and more.

percent and 10 percent of their impervious surfaces during the next 25 years.

Between the two cities, Montalto continues to monitor as many as 25 green infrastructure sites, including so-called "Greenstreets"—vegetated spaces within a city that were historically built for beautification purposes that are now being designed to manage street runoff.

By installing a sensitive scale—a weighing lysimeter—beneath a portion of a Greenstreet to monitor changes in mass, Montalto says he is able to measure directly how much water is actually evaporated from that green space. He already has weighing lysimeters in two different "greened" traffic islands in Queens, N.Y., in Alley Pond Park, one of the last old growth forests in New York City, as well as on a green roof at the Ethical Culture School in Bronx, N.Y. This fall, he will be adding five new lysimeters to the roof of the Jacob Javits Convention Center in Manhattan, which will soon host the second largest green roof in the nation.

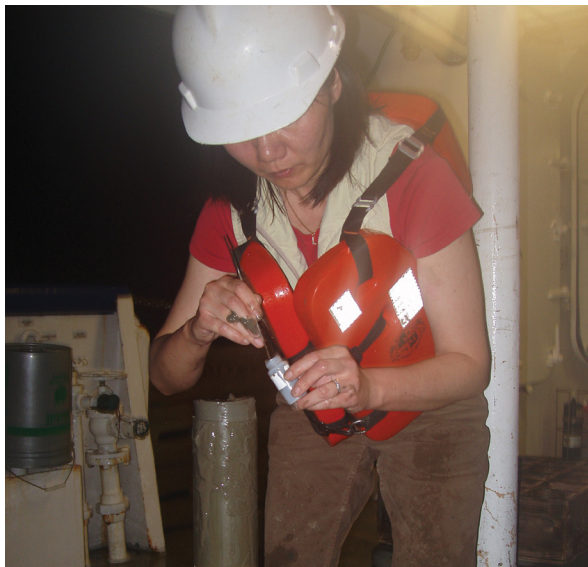


## BIOLOGY

## SOCIOLOGY / ENVIRONMENTAL SCIENCE

## \_IMPACT OF ALGAL BLOOMS

*'Phytoplankton' and 'algal blooms' aren't exactly household words—but too much of either can have a serious impact on the food chain and, more importantly, human life.*



**A**CADEMY of Natural Sciences of Drexel University scientist Ling Ren has spent the last few years studying blooms of phytoplankton, a type of algae that lives near the surface of water.

The green muck may seem harmless, but as it turns out, algae can play a massive role in the health of ecosystems.

Phytoplankton grows naturally when light, temperature and nutrients such as nitrogen and phosphorus are balanced. However, excessive nutrient inputs, warmer water temperatures and plenty of light can cause growth to occur too quickly, resulting in rapid expansion of massive phytoplankton populations. These "blooms" sink to the bottom of waters along the coast where they decompose and consume oxygen.

"Some forms of phytoplankton can also produce toxins, which may be accumulated in shellfish or fish



**\_LING REN**

Ren is a scientist at the Academy, with research interests in Eutrophication, harmful algal blooms and the Barnegat Bay.

via the food chain and eventually be harmful for human consumers," Ren says.

In 2009, along with scientists from China's Zhejiang Ocean University (ZJOU), Ren began a project to evaluate the ecology of the Zhoushan Fishery region of the East China Sea by re-examining how phytoplankton blooms affect fish resources. This information will eventually provide a scientific basis for future coastal management and ecological restoration.

During the three-year project, Ren set up small-scale experiments to study the nutrient inputs on phytoplankton by recreating the conditions that spur algal blooms. She also trained Chinese graduate students to carry out these experiments and will return to China this November to check their progress.

Ren recently received funding to focus her research closer to home, in New Jersey's Barnegat Bay. This area has seen significant changes over the past few decades, mainly attributed to human activities in the area including population growth, and increases in industrial development and agriculture.

During this two-year project, Ren hopes to learn more about phytoplankton blooms, their relationships to human activity and how these blooms are affecting its grazers—such as aquatic insects, shellfish, fish—and the long-term ecology of the bay. There are also harmful phytoplankton that can bloom in Barnegat Bay, including "brown tide" blooms that can affect shellfish growth and reproduction.

Ren will collect and analyze water samples from the bay to determine phytoplankton species diversity and how it changes over time—an abundance of certain species can tell a story about the water quality of the bay.

Her project is one of many bay-wide monitoring studies currently being conducted by Academy scientists. Ren's results will provide a better understanding of current water quality issues, which will contribute to better management and restoration of critical natural resources within the bay.

## \_CLIMATE CHANGE TRENDS

**Y**OUR BELIEF—or disbelief—in the legitimacy of climate change may be determined by whether you vote red or blue on Election Day, a recent Drexel study suggests.

Robert Brulle, a professor of sociology and environmental science at the College of Arts and Sciences, conducted a study to identify the international, cultural and political processes that influence the public's attitude concerning climate changes.

The study, performed with Jason Carmichael of McGill University and J. Craig Jenkins of Ohio State University, was recently published in *Climatic Change*, one of the world's top 10 climate science journals. The trio's paper, "Shifting public opinion on climate change: an empirical assessment of factors influencing concern over climate change in the U.S., 2002-2010," uses empirical analysis to examine the many factors affecting U.S. public concern about the threat of climate change from January 2002 through December 2010.

In 2004, about 26 percent of the respondents stated that they worried "a great deal" about global warming. By 2007, this proportion had risen to 41 percent. But by 2010, that number dropped to 28 percent.

The question, of course, is simple: *Why?*

Brulle and his colleagues accounted for five factors when designing the study: extreme weather events, public access to accurate scientific information, media coverage, elite cues and movement/counter-movement advocacy. A time-



*"Public opinion regarding climate change is likely to remain divided as long as the political elite send out conflicting messages on this issue."*

*-Robert Brulle, professor of sociology and environmental science*

series analysis indicates that public concern about climate change is affected the most by elite cues—specifically, conflicting policy cues from political party leaders—and structural economic factors.

"Public opinion regarding climate change is likely to remain divided as long as the political elite send out conflicting messages on this issue," Brulle says.

The state of the economy also affects public opinion on climate change, but the other factors considered during the study were less influential. For instance, extreme weather events did not have a significant effect in the overall level of public concern regarding

## \_ ONLINE

For a Q&A with Ling Ren, visit [EXELmagazine.org](http://EXELmagazine.org)





## \_Q&A WITH MIMI SELLER





Throughout her career, Drexel sociology professor **Mimi Sheller** has examined the many different forms of “mobility” in public life. *by Kelly Andrews*

**M**IMI SELLER EXAMINES how people move, how mobile communication changes how people move and how new systems of mobility can actually create immobility. It's no wonder, then, that she's designed Drexel's Center for Mobilities Research and Policy (mCenter) to cross boundaries within disciplines and within Drexel. As the founding director of the mCenter, she works across the university and across nations to better understand these mobilities, which she defines as “the large-scale movements of people, objects, capital, and information across the world, as well as the more local processes of daily transportation, movement through public and private space, and mobile communications.”

In January, Sheller was invited to Tokyo by World Bank to share her expertise and work with an international team of experts seeking to draw out lessons from the 2011 Japanese earthquake and tsunami for disaster preparedness planning.

#### *What brought you to Drexel?*

After helping to found mobilities research at Lancaster University in the UK, I came back to Philadelphia, where I'm from originally, with the idea of bringing mobilities research, which was really taking off in Europe, into a U.S. academic context. Drexel had a very forward-looking interest in interdisciplinary fields that could draw together its different colleges and schools.

Mobilities research intersects with engineering

around infrastructure and sustainability, with The iSchool at Drexel around issues of information technology, with the College of Arts and Science with the interest in social issues, with Westphal and issues of design interfaces, and with the School of Public Health around health and access concerns. I saw how it could help build those bridges within Drexel and also bring valuable connections to existing international contacts and networks outside of the U.S.

#### *Who are you working with?*

I recently worked on a very exciting project funded by the National Science Foundation (NSF) on post-earthquake Haiti with colleagues in the department of civil and environmental engineering. It was a project on participatory engineering—how local knowledge could be mobilized in the post-earthquake situation to work with people there on their water and sanitation needs. There is a real movement in engineering to involve communities in infrastructure decisions, which connects engineering to social science. We are now collaborating on further funding applications on green infrastructure, water and sustainability and climate change.

I'm also co-leader of a research initiative on “Augmented Philly,” which will form part of the new Expressive and Creative Interaction Technologies Center (ExCITe) under the direction of Youngmoo Kim and Adam Fontecchio from the College of Engineering.

We hope to get NSF funding to develop a city-wide collaborative project to develop new mobile interfaces and interactive technologies for social connection and civic engagement with urban neighborhoods through innovative forms of public art and mobile gaming. Potential partners include Breadboard and NextFab at the Science Center; the Center for Creative Economy at University of the Arts; the Philadelphia Game Lab; and Azavea, a local software development company.

#### *Is that how you became involved with the World Bank in addressing disaster preparedness?*

After we did the project in Haiti, the Earthquake Engineering Research Institute (EERI) invited us to a workshop they had organized on behalf of the NSF to review all of the teams that had worked in post-earthquake Haiti. They asked me to co-chair the meeting in October 2010, about nine months after the earthquake. This year the World Bank invited the EERI to bring a team of international experts to Tokyo to work with a Japanese team on lessons learned from the 2011 earthquake and tsunami. Specifically, the World Bank wanted lessons for developing countries. They invest a lot of program funding in development projects, and they realized that development needs to take disaster preparedness into account, especially in these days of climate change and severe weather events. Large-scale development projects can

be impacted by disaster, and countries can use development planning and funding to help prepare for floods and hurricanes and tsunamis and droughts—whatever disaster might strike.

A team of 12 of us—four from the U.S., including myself—went to Tokyo and had an amazing set of sessions with representatives from the World Bank, the Japanese government, and Japanese NGOs that had been involved in disaster response. They presented a lot of information on what they had learned, and we advised them on translating that into something useful for developing countries.

The final version will be presented at the World

*“There is a real movement in engineering to involve communities in infrastructure decisions, which connects engineering to social science.”*

Bank/International Monetary Fund (IMF) annual meeting in Japan in October. At that meeting the report will go out to all the member states of the IMF and the World Bank so that they incorporate these lessons into future development.

#### *How can someone learn more about the mCenter?*

We sponsor a Mobility Visiting Speaker Series, which is open to the public, and I always welcome suggestions for speakers to invite. Follow our blog at mCenterDrexel.wordpress.com, mCenter @ Drexel on Facebook, or @ mCenterDrexel on Twitter, to get involved.



## \_DIABETES CRISIS

**D**IABETES IS NOW one of the most common non-communicable diseases—but according to a recent Drexel study, the disease is taking an extra toll in the developing world.

Rates of diabetes vary widely across developing countries worldwide, says researcher Longjian Liu of the School of Public Health, but worldwide, four in five people with diabetes now live in developing countries. Liu's study also found that access to healthcare support for diabetes varied widely in developing countries, and that one in 10 diagnosed cases remain untreated.

"[Diabetes] is the fourth or fifth leading cause of death in most high-income countries, and there is substantial evidence that it is an epidemic in many low- and middle-income countries," Liu says.

The number of people with diabetes is expected to increase substantially in coming decades.

Many past studies have measured rates of diabetes in developing countries using different methods, leaving researchers unable to make direct comparisons between countries. Liu's team analyzed data from the World Health Organization's World Health Survey, one of the first and largest global surveys using a standard method to measure

*"[Diabetes] is the fourth or fifth leading cause of death in most high-income countries, and there is substantial evidence that it is an epidemic in many low- and middle-income countries,"*

*—Longjian Liu, researcher at the School of Public Health*

the rates of chronic conditions in multiple countries worldwide. Liu's team included a total of more than 215,000 subjects from 49 countries in their analysis. The countries represent a variety of regions, including Africa, the Americas, Europe, Southeast Asia and the Western Pacific.

The prevalence of diabetes varied widely,

from a low of 0.27 percent in Mali, to 15.54 percent in Mauritius. Researchers noted that age is a common factor in diabetes; the low rate observed in Mali may reflect that country's low life expectancy due to infectious diseases.

The study results showed that so-called "adverse body weight"—being underweight, overweight or obese—was associated with increased risk of diabetes. People with diabetes who were underweight were the most likely to go untreated.

Liu and colleagues noted that it is important to identify and address the lack of treatment because diabetes is an independent risk factor for additional health problems and complications, including heart and kidney diseases. Such complications "are resulting in increasing disability, reduced life expectancy and enormous health costs for virtually every society," Liu says.

## \_AUTISM FINDINGS

*A Sweden-based study led by Drexel researchers shows smoking during pregnancy does not cause autism.*



**\_BRIAN LEE**  
Lee is an assistant professor in the School of Public Health. His research focuses on the environmental determinants of autism spectrum disorders and more.

obstetric complications.

In addition, past studies of maternal smoking and autism have shown mixed results, with neither proving nor disproving the correlation.

Lee and his colleagues searched Swedish national and regional registries, analyzing 3,958 children with ASD and a control set of 38,983 children born during the same time period who did not receive an ASD diagnosis.

They found that 19.8 percent of the ASD cases were exposed to maternal smoking during pregnancy, while 18.4 percent of the control group were exposed to maternal smoking. During unadjusted analysis, the rates show an association between maternal smoking and the odds of an ASD diagnosis.

However, once the analysis was adjusted for certain sociodemographic factors such as the parents' income, education and occupation, the association disappeared.

The results of the study can help reassure mothers that the act of smoking during pregnancy was likely not responsible for their child's autism, and as Lee explains, "crosses off another suspect on the list of possible environmental risk factors for ASD."

Although maternal smoking does not seem to increase the risk of autism spectrum disorders, Lee says is important to note that smoking during pregnancy is still very unhealthy for mothers and developing babies.

**P**RENATAL EXPOSURE to tobacco smoke has been suggested as a possible contributor to the development of autism spectrum disorders (ASD), but a recent population-based study spearheaded by researchers at Drexel's School of Public Health indicates that the two may not actually correlate.

"We found no evidence that maternal smoking during pregnancy increases the risk of autism spectrum disorders," says Brian Lee, an epidemiologist and assistant professor at the School of Public Health.

Lee led the Sweden-based study, which will be featured in an upcoming edition of the *Journal of Autism and Developmental Disorders*, with a team of international collaborators.

Researchers have believed environmental exposures—anything not heritable—are likely relevant to the etiology of ASD, and many have thought tobacco smoke was a possible cause because of known associations with behavioral disorders and

**4 IN 5**  
PEOPLE WITH  
DIABETES LIVE  
IN DEVELOPING  
COUNTRIES





## \_HIV ADVANCES

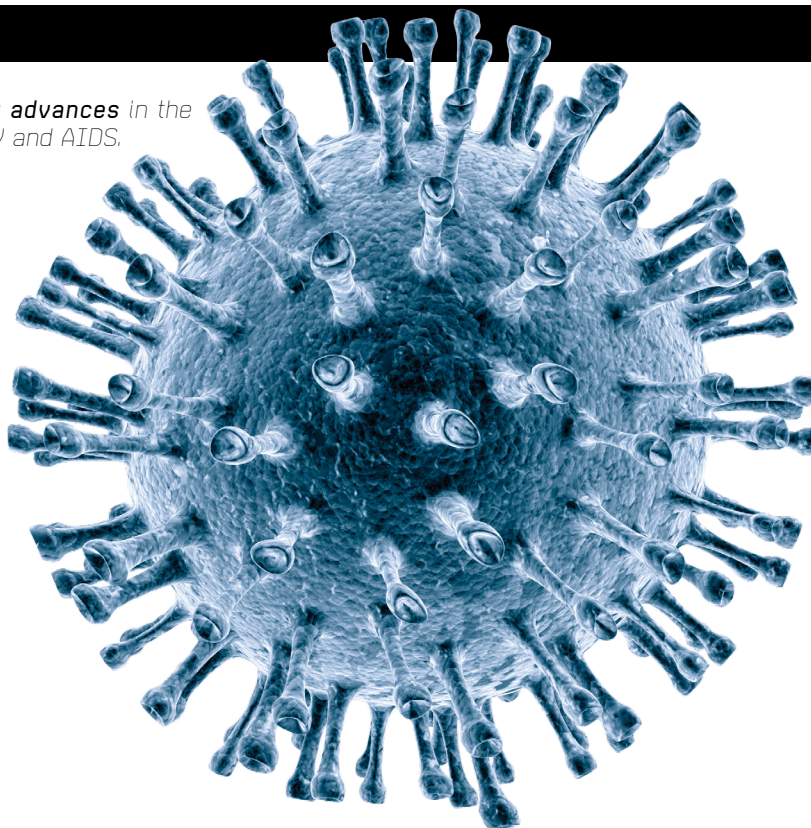
Drexel researchers are *pioneering advances* in the treatment and understanding of HIV and AIDS.

## Seeing a 'Functional Cure'

**J**EFFREY JACOBSON, chief of Drexel's division of infectious diseases and HIV medicine, is developing a therapeutic vaccine to control HIV in already infected individuals. Since HIV mutates very readily to evade the body's immune response, each individual has slightly different quasispecies, or strains, of HIV. Therefore, the vaccine would have to be personalized for the individual, according to Jacobson, who is the principal investigator.

To create the vaccine, a sample of the virus is taken from the infected individual's own blood before HIV drugs are started. Investigators then take the RNA of the person's virus, load it into the person's own immune cells and give it back as a vaccine to try to stimulate a new, more potent response against HIV. The ultimate goal of the research, which is funded by the National Institutes of Health, is a "functional cure" of the infection—control of HIV without the need for any HIV medications.

Jacobson also has NIH funding to study a long-acting injectable anti-HIV antibody as an alternative treatment for HIV-infected patients who have demonstrated an inability to adhere to the rigors of taking daily oral anti-HIV medications.



## STILL\_DEADLY

Despite the amazing advances made in the fight against HIV and AIDS, the disease remains a massive global health problem. More than 25 million people worldwide have died of AIDS since the start of the epidemic in the early 1980s, and the disease is the No. 6 cause of death among adults aged 25-44 in the United States.

## A Warning About HAART

**D**REXEL School of Public Health professor Seth Welles was a partner investigator on a new study that found that highly active antiretroviral therapy (HAART) is not as effective in suppressing HIV in certain HIV-infected individuals.

According to Welles and his fellow investigators, the implications of this research are extremely important, especially for HIV-infected men who have sex with men (MSM). The researchers point out that MSM may make sexual decisions based on their incorrect understanding that being on HAART and having undetectable blood viral load means they cannot transmit HIV. They may assume that HAART eliminates HIV in semen.

The study helped to explain the relationship

between HAART, which reduces viral load, and risk factors for HIV. Other risk factors for HIV include STIs and genital inflammation, which enhance HIV replication in the genital tract and increase possible sexual transmission of HIV.

Based on their data, the researchers concluded that this higher prevalence of HIV in semen in MSM with undetectable levels of HIV in their blood is likely due to other STIs as well as genital inflammation. In other words, STIs and genital inflammation may lessen the effectiveness of HAART and transmission may still be possible.

Welles and his fellow investigators cautioned that more research needs to be conducted and made available both to HIV-infected MSM and their health care providers.

## Stopping AIDS Before it Starts

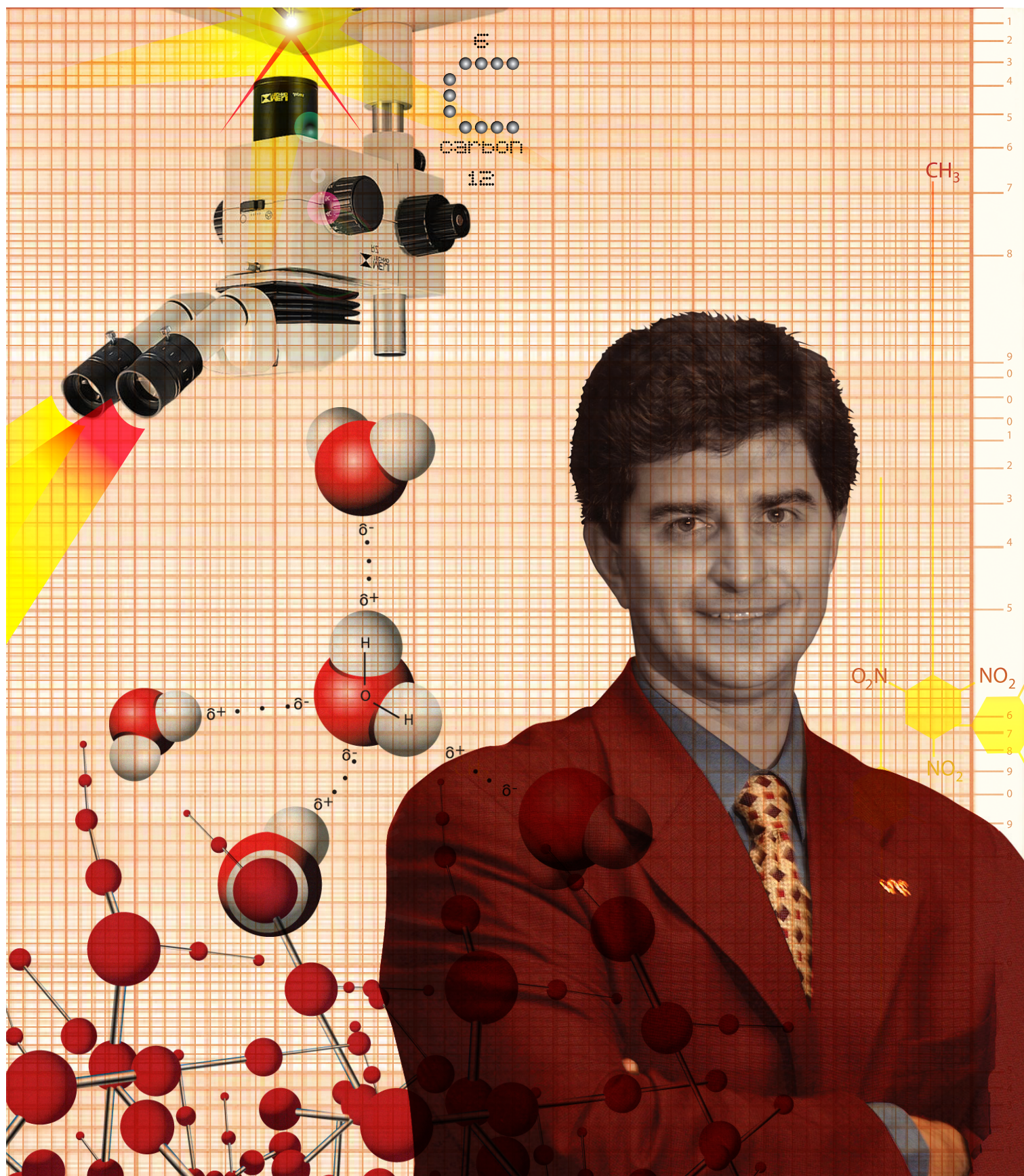
**D**REXEL College of Medicine professor Irwin Chaiken and his colleagues have found a class of compounds—peptide triazoles—that block the HIV virus-cell interaction. Some of these compounds also have the ability to "break" and thereby inactivate the virus before it encounters a host, while leaving the human cells undisturbed.

HIV infection is initiated by entry of the virus into a host cell, a process that depends on the fusion of the viral membrane with the membrane of the target cell. One very effective approach to preventing and potentially treating infection would be to inhibit this fusion.

This finding could lead to prevention and treatment options at the earliest stages of HIV-1 exposure. The peptide triazoles have the ability to inhibit the virus from multiple subtypes of HIV that are globally important. So far, they appear to work in all subtypes of the virus that have been tested.

Chaiken's lab has collaborated in this research with Drexel engineers as well as a multi-institutional National Institutes of Health program project team.







# CATALYST

A PINPOINT-SIZED

Drexel's Yury Gogotsi has transformed the **A.J. Drexel Nanotechnology Institute** into a world-class hub for studying science's smallest frontier.  
*\_by Brian Schleiter / Illustration by 500gls*

**B**EGINNING IN THE 1970s, some scientists promoted the idea that massive amounts of hydrogen, a renewable source of energy, could be stored in fuel cells made with newly discovered and highly promising carbon nanomaterials. A new generation of cars, trucks and boats would replace the gas-guzzling models of the day, it was believed, reducing the United States' dependence on foreign oil and significantly improving the environment.

Those scientists gave their idea a catchy name: "The Hydrogen Economy."

For politicians looking for a way to reduce soaring inflation caused in part by rising prices at the gas pump, the timing couldn't have been better. Government money flowed freely into new hydrogen research projects. Fueled by private investment, the major American automobile manufacturers spent millions ramping up their research and development units.

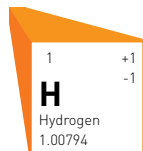
Yet more than 40 years later, almost nobody is actually driving a hydrogen-powered car. The technology never materialized, it turns out, because the scientists greatly over-estimated the amount of juice they could realistically squeeze from the novel fuel cell.

Drexel's Yury Gogotsi has spent his entire career studying materials science and is a leading figure in nanotechnology research. He's also a student of history, and understands that science—for all of its great contributions to the world—is not without its faults. The hype that powered the imagined "Hydrogen Economy" is just one example.

"In many fields of science, whenever an emergency appears, there's a lot of good work going on, but also a lot of hype. There are scientists who make unreasonable claims," Gogotsi says.

Now, he worries, history may be about to repeat itself.

In a pointed perspective he recently co-authored for *Science* magazine with colleague Patrice Simon of the Université Paul Sabatier in Toulouse, France, Gogotsi argues researchers should pause and consider a new, standardized gauge to measure the performance of an emerging generation of energy storage devices that range from ones as small as those used in cell phones to ones as large as those used in the nation's energy grid.



## AVOID THE HYPE

As with the so-called Hydrogen Economy, scientific hype often outraces scientific reality. Says Gogotsi: "There are scientists who make unreasonable claims."





a professor in Drexel's department of materials science

and engineering and director of the A.J. Drexel Nanotechnology Institute, is chiefly concerned with the global race to build better "supercapacitors," which are used now to power buses and trams and to open emergency doors on the world's largest aircraft. Newly discovered nano-size materials used to build supercapacitors carry great potential for increasing their energy storage ability.

But Gogotsi worries that the current system for evaluating energy storage devices is insufficient and may not provide a complete picture of the devices' actual capability. As happened with the hydrogen fuel cell, it's entirely possible that the data assumptions made in the lab using small amounts of nanomaterials won't hold up when production is scaled up, and the entire energy storage field could suffer.

"We needed to provide a reality check for the community. We need to work on a better technology, but we need to correctly evaluate the result. Otherwise the hype does more damage than good," he warns.

#### IF YOU BUILD IT, THEY WILL COME

Gogotsi's *Science* magazine article has been well received in the materials science research community. It's also helped further enhance the reputation of Drexel's materials science and engineering department, already considered one of the best in the country.

"Publishing a paper in *Science* is like climbing Mount Everest," Gogotsi says.

Growing up in Kiev, Ukraine, Gogotsi didn't dream of climbing mountains. From the time of his first middle school chemistry class, he knew he wanted to be a scientist.

"I fell in love with science pretty early. It was really intuitive. I fell in love with chemistry. I couldn't understand everything and I was very much excited and wanted to learn more," he says. "I feel the same way now, many, many years later."

Gogotsi earned his Ph.D. at Kiev Polytechnic Institute, Ukraine and continued his Materials Science training as a research assistant at the Academy of Sciences of Ukraine. Following fellowships in Germany, Japan and Norway, he accepted an assistant professor appointment in mechanical engineering at the University of Illinois at Chicago. When Drexel recruited him to jumpstart its

fledgling nanotechnology program in 2000, he dispatched two of his graduate students to Philadelphia to check the lab space he'd been given. They returned with bad news: The facilities were too inadequate for them to complete their degrees, and they decided not to move with him.

"It just didn't have necessary equipment for nanotechnology research," he recalls. "There were no instruments."

In 2002, when Gogotsi was named associate dean of the College of Engineering for Special Projects, he was given a mandate to build out a nanotechnology infrastructure. In February 2003, he founded and was appointed director of the A.J. Drexel Nanotechnology Institute. Though somewhat of an uncommon practice, he also sought and was given courtesy appointments as professor of mechanical engineering and mechanics, and assistant professor of chemistry.

His first priority was to build a state-of-the-art lab with high-end research instruments, not just for his materials research, but for use among research scientists across many Drexel disciplines.

Today, the Centralized Research Facilities (CRF) provides access to advanced equipment for electron microscopy, vibrational spectroscopy, elemental analysis, X-ray diffraction, nanoindentation and micro fabrication.

To mechanical engineers and materials scientists, CRF was the equivalent of a "Field of Dreams"—once built, it attracted many new faculty members to Drexel. There are currently nearly 50 nanomaterials researchers at the university, and the materials science and engineering department was ranked No. 11 in the prestigious National Research Council (NRC) rankings, which came out last fall.

"This is very good for a small department," Gogotsi says of the NRC ranking. "It just shows the result of the effort of the entire university community. I'm glad I was part of it and was able to contribute, and I hope the university will be able to keep the pace."

#### THE NEXT BIG THING

Keeping pace means staying ahead of the field and anticipating where the research might be heading next. In the world of materials science, the latest craze is nanodiamonds.

First discovered in the former Soviet Union in the 1960s, these tiny particles of carbon originate in the first milliseconds when TNT is detonated during controlled explosions in large containers. In black powder form, nanodiamonds bear little resemblance to precious bulk diamonds, but their value to scientists has steadily increased since the late 1990s.

Diamond nanoparticles have a broad range of existing applications. They are used as additives in high performance motor oil, where they act as a lubricant to decrease engine wear and noise and improve performance by increasing fuel consumption. Diamond nanoparticles also absorb sunlight very well, and they've been used to make

*"We needed to provide a reality check for the community. We need to work on a better technology, but need to correctly evaluate the result. Otherwise, the hype does more damage than good."*



better sunscreens. In comparison to other nanotechnologies, they are relatively inexpensive to make.

The greatest promise for nanodiamonds, however, may be their ability to deliver chemotherapy drugs to cancer cells without producing some of the negative effects common with today's delivery agents. Diamond nanoparticles are nontoxic and non-inflammatory, and because they are so small—hundreds of thousands can fit on the tip of a pin—they are easily removed from the body.

"There has been some prominent work showing that cancer drugs can be much more efficiently delivered using diamond nanoparticles," Gogotsi says. "We would like to lead this challenge and be among the first to develop applications for diamond particles."

Biomedical applications must be clinically tested and are still a decade away, A.J. Drexel Nanotechnology Institute research assistant professor Vadym Mochalin estimates. But companies are working with his team on several more immediate and practical uses for nanodiamond particles. An example is ongoing work to develop the next generation of polymers for dissipating heat that builds up in increasingly small electronic devices and gadgets, so your iPod "doesn't become a boiler plate" in your hand, Mochalin says.

Nanodiamond particle research is helping grow the Institute's reputation, both at home and abroad. The Institute recently announced a collaboration with Shanghai Research Institute in China, sending M.S./Ph.D. student Amanda Pentecost there for six months to work on a nanodiamond particle agent capable of treating brain tumors. And the Institute's nanodiamond group was invited to organize the first-ever dedicated symposium on nanodiamond particles at the Materials Research Society Meeting in San Francisco, Calif., the largest conference of its kind in the world. The group made nine oral and poster presentations.

"This, I think, shows Drexel is one of the leaders in this area of biomedical and composite applications of nanodiamonds," Mochalin says.

Gogotsi says he appreciates the accolades and honors bestowed on him by his peers and others, but there's little time to reflect on his past achievements. Balancing his responsibilities in the lab, in the classroom and as a student advisor is a daily struggle—"I'm never bored," he says. But his life's work has been spent building things—both big and impossibly small—and he has no plans of slowing down now.

"My interest is in trying to identify new materials which can make a difference and develop them, and to make Drexel a leader in this area of research," he says.

*"My interest is in trying to identify new materials which can make a difference and develop them, and to make Drexel a leader in this area of research."*



#### EXPLOSIVE TECH

Diamond nanoparticles, carbon particles, which originate in the first milliseconds when TNT is detonated during controlled explosions, are already known to have several real-world applications. But Gogotsi and others believe their greatest use may be in the fight against cancer, as these particles can be used to more precisely deliver cancer drugs.

#### THE NEXT GENERATION



GOGOTSI'S EARLY EXPOSURE to chemistry and the profound effect it had on him in part explains why he insists that community educational activities be a primary focus of the Nanotechnology Institute. In 2004, at his urging, Drexel applied for and received National Science Foundation funding to support a new

program called Research Experiences for Teachers in the area of Nanotechnology.

"When I give talks in high schools," he explains, "maybe one kid will get excited." The classroom teachers, however, often were enthralled by his presentations.

"If we want to have good scientists, good engineers in the future, we must start the work early. And the best way to reach high school students is through teachers," he says.

For seven weeks each summer, selected high school and community college teachers receive hands-on experience working in research laboratories at Drexel and the University of Pennsylvania. They attend lectures about nanotechnology and develop experiments and lesson plans to take back to their classrooms. The response from students has been overwhelmingly positive.

"It gets kids excited. It's really an exciting opportunity to educate the younger generation and also re-train teachers to help them to bring advanced science into the classroom," Gogotsi says. "I believe educational activity is really a very important part of the Nanotechnology Institute's mission."

In 2008, Gogotsi was appointed materials science and engineering trustee chair professor. Two years later, he was named Distinguished University Professor, one of only two Drexel faculty members to receive the annual honor. The title is bestowed upon full professors who "have distinguished themselves in their respective fields through research, scholarship, clinical innovation or creative work."

Over the years, Gogotsi has mentored many young students, helping them focus their creative energies and shaping their careers, much the same way they manipulate the surface of the tiniest particles and molecules known to man. Mochalin has worked closely with Gogotsi for the last seven years.

"I'm very satisfied. I have learned a lot from him. Now I'm also teaching. I've adopted many of his methods of teaching," Mochalin says. Despite the many professional hats he wears, Mochalin adds, Gogotsi "always provides any kind of help I ask for."





\_SHOULDER SOCKET

The HUBOs' shoulders have three motors—pitch, roll and yaw—which provide the robot with the range of motion similar to that of a human. This enables the HUBO to perform such tasks as throwing a baseball.

\_FIVE DIGITS

Each hand has five fingers, controlled by individual motors. The hands are capable of shaking hands with a person or holding light objects, such as a pair of drumsticks.

\_KNEE JOINT

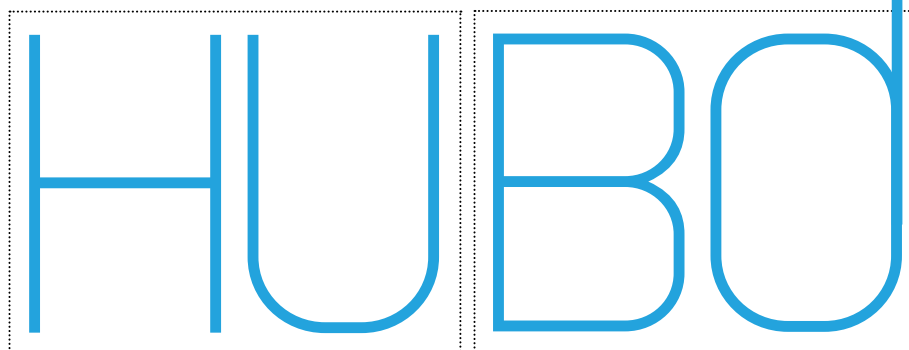
The knee is one of 12 joints in the lower body that, when precisely coordinated, allow the HUBOs to walk. On a flat surface, the robot can walk at just more than one mile per hour, and run at slightly more than two miles per hour.

\_NAME : Jaemi Hubo  
\_HEIGHT : 4' 3"  
\_ACQUIRED : 2009

The HUBOs are humanoid robots, built to resemble humans. With two legs, two arms, a torso and a head, they can mimic human motions and gestures. Six new HUBOs followed Jaemi and arrived at Drexel in 2012.



\_HUMANOID



\_ROBOT

WITH THE HELP OF COLLEAGUES FROM AROUND THE WORLD AND A TROUPE OF MUSICAL ROBOTS, DREXEL'S **YOUNGMOO KIM** IS PUSHING THE BOUNDARIES OF MODERN ROBOTICS.

\_by Maria Zankey / photographs by Melissa Marie Hernandez

JAEMI HUBO HAS BEEN at Drexel University since 2009.

In three years at the College of Engineering, Jaemi has become an active and integral member of the Drexel Autonomous Systems Laboratory (DASL, pronounced “dazzle”), and through the countless hours spent in the Music and Entertainment Technology Laboratory (MET-lab), Jaemi has shown the ability to hold her own on the dance floor, too. Which is why Jaemi was chosen to perform on stage at the Main Building Auditorium to kickoff this

year’s Engineers Week festivities in February. But unlike most others in the College of Engineering, Jaemi isn’t a student. Jaemi’s not even a researcher. Instead, Jaemi is the researched.

Jaemi is a humanoid robot, or “HUBO,” a type of lifelike robot developed by Drexel’s overseas research partner, the Korea Advanced Institute of Science and Technology (KAIST). Standing at 4-feet, 3-inches and weighing about 100 lbs., The HUBO’s design and functionality is a great deal more sophisticated than the average robot. It has a slimmer figure than most, with an aluminum endoskeleton and polycarbonate frame. Its arms can move freely—as can its 10 fingers—and its legs allow it to stride more like an actual human than its robot cousin, Roomba.

Oh, and then there’s this: Jaemi, one of seven brothers and sisters (well, to be clear, these robots are gender neutral), is crazy about music. Since Drexel obtained Jaemi in 2009, KAIST has flown six more identical robots to Drexel in increments,



\_YOUNGMOO KIM

Kim is an associate professor of electrical and computer engineering, assistant dean of media technologies and director of the Music and Entertainment Technology Laboratory.



and when the final two robots arrived at Drexel in late February, it marked the largest gathering of HUBOs in robotics history—a feat that is as meaningful as it is impressive.

“By bringing seven robots here and standardizing the research, now everyone is studying on a level playing field,” says Youngmoo Kim, director of the MET-lab, an associate professor of electrical engineering and assistant dean of media technologies in the College of Engineering. “Now, it’s a very apples-to-apples comparison.”

With the accumulation of so many identical robots opening doors for new comparative research, engineers at Drexel are elevating the field of robotics to unprecedented ground—and they’re doing so with a little rhythm in their step.

#### A HUB FOR HUBOS

Drexel’s partnership with KAIST began in 2008, when mechanical engineering and mechanics department head Paul Oh visited the institute’s HUBO laboratory, where the robots were originally designed and built.

“You can’t buy a humanoid in the U.S. [So Oh thought,] ‘Why don’t we use this opportunity to work with those who do and who are the best in the world with it?’ which is KAIST and HUBO lab,” Kim says. “We wanted to use it not as just a way to use a really great piece of equipment, but also to learn from that experience on both sides.”

“At KAIST, their primary focus is in mechanical engineering, and they do great design, but there’s not as much focus

in software, artificial intelligence or machine learning,” Kim added. “We have a lot more expertise in those areas, so by partnering, we get the best of both worlds.”

Since then, Kim says, Drexel students have traveled to the South Korea for co-ops at KAIST, while KAIST

students have also traveled here to study at Drexel. Jaemi’s arrival to University City in 2009 was made possible in part by a five-year, \$2 million grant from the National Science Foundation’s Partnership for International and Research Education Program (PIRE).

In August 2010, the NSF awarded a \$6 million Major Research Instrumentation (MRI) grant to a group of U.S. institutions led by Drexel to expand upon research with Jaemi and bring the six additional robots in for study.

Robotics researchers from the seven collaborating universities—Massachusetts Institute of Technology, Carnegie Mellon University, Virginia Tech, the University of Southern California, the University of Pennsylvania, Purdue University and Ohio State University—will travel to Drexel to learn how to operate the HUBOs.

“It really is kind of an all-star team we’ll be working with,” Kim says, adding that the group consists of many “world-famous roboticists,” maintaining previous academic relationships and also building some new ones.

“We’ll be teaching them how to turn them on, how not to let them fall down, how to calibrate the robot,” Kim says with a laugh. “In some ways, the way you have to deal with these robots is worse than having a baby. It takes a long time before the robot can do something really simple. We’re work-

#### \_GRASPING MECHANICS

The fingers are controlled by a motor and a wire strung through a series of pulleys. As the motor pulls on the wire, the fingers curl until they meet resistance from another object. This allows the fingers to conform to the shape of irregular objects.

*“I can tell you a list of 100 things I think humanoids could do—none of which they’ll be able to do in a year, or even five years. But unless we start doing that basic research right now, we’ll never get there.”*





**\_JAEMI'S SIZE**

Standing at 4'3" tall, HUBO is an adult-sized humanoid. Although short for an adult human, the HUBOs are tall enough to stand at a desk, reach a doorknob or play a full-sized piano.



# HUBO

## KAIST

### Rainbow

#### HUBO



ing to improve that, too, but we'll be teaching our partners some of the things you only get by working with the robots."

Eventually, each of the robots will be shipped to the partner institutions to be studied on an individual basis. But for now, Kim and his colleagues in the MET-lab have plans for the seven-part humanoid dance troupe.

#### THE AIM? TO BE MORE HUMAN

While the HUBOs are sophisticated in the realm of humanoid robots, they still need a fair amount of coddling.

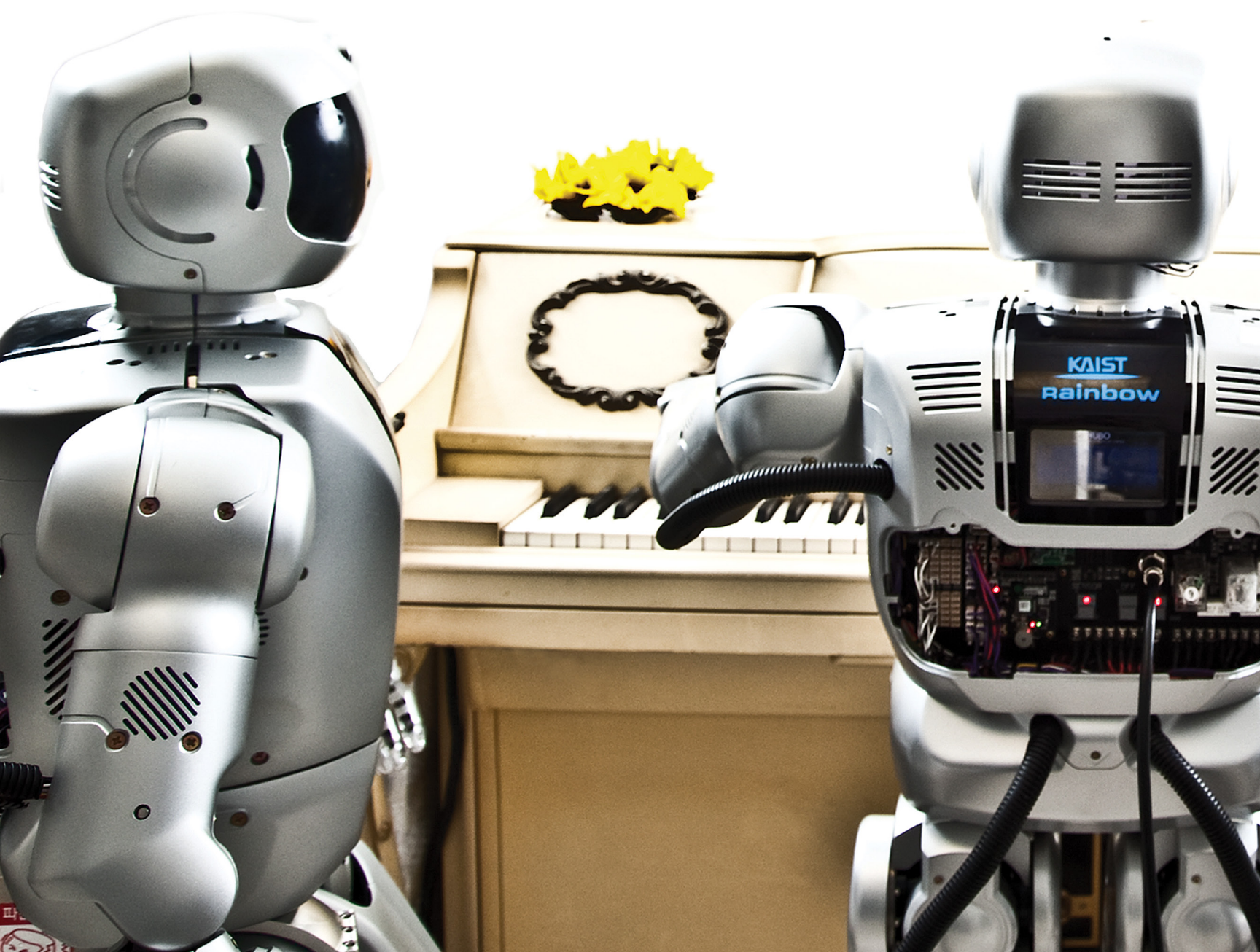
"Humanoids haven't gotten a lot of attention because there's not necessarily a direct application for them right on the horizon—that's what makes it a long-term research problem," Kim says. "I can tell you a list of 100 things I

think humanoids could do—none of which they'll be able to do in a year, or even five years. But unless we start doing that basic research right now, we'll never get there."

Kim says that was the goal of the MRI grant—to create a new research platform by enhancing the robots.

"These robots have a great design, but they're fairly limited. They can't see things, they can't hear, they can't touch," Kim says. "We're going to be putting in new cameras, microphones and tactile sensors, and then build a whole new software architecture so it can take in all that data. Right now, it can't."

The possibilities for a sensitive robot are vast, Kim says, but whether the humanoid is dancing to the beat of a tune or just standing still, they're controlled by computer programs.





**ONLINE**

See the HUBOs perform "Come Together" at [EXELmagazine.org](http://EXELmagazine.org)

**MUSIC BOTS**

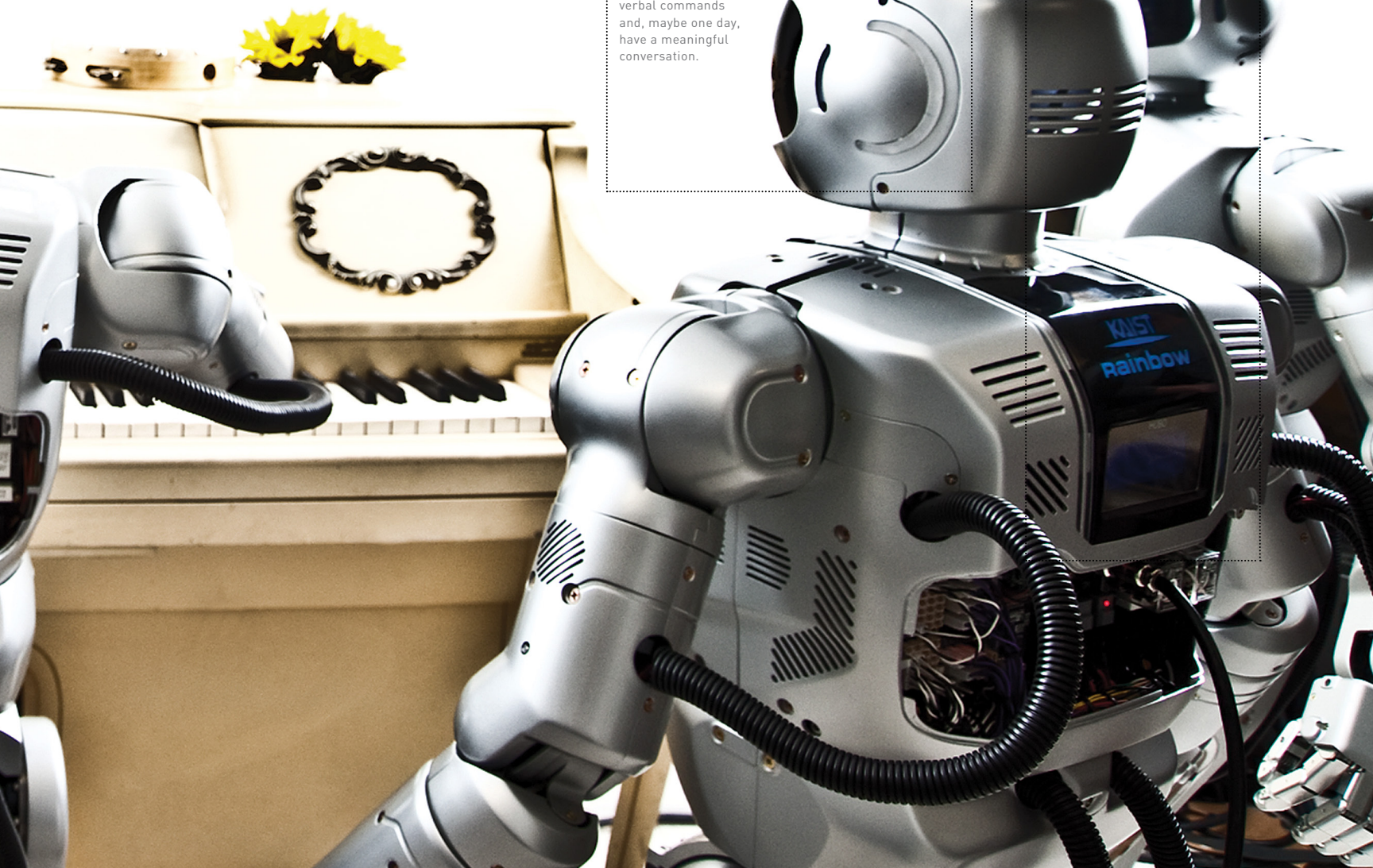
Since arriving at Drexel, the HUBOs have spent significant time playing and listening to music. Students in Drexel's MET-lab are working to improve how robots interact with humans through music, movement and creative expression. Four HUBOs performed a cover of "Come Together" by The Beatles, using a drum set and three custom "Hubophones," instruments made of PVC pipes tuned to different notes. This was released as a music video on YouTube and has received more than 150,000 views.

**INNER ELECTRONICS**

Each HUBO is powered by two computers with Intel Atom CPUs, used in many notebook computers. One of the computers sends commands to the motor controllers, printed circuit boards dedicated to precisely actuating the motors of each joint. The second computer provides additional processing power for analyzing the input from sensors. Each foot and hand contains a sensor that records how much force is experienced at that particular joint, and camera and microphone inputs are also available to process sight and sound.

**SENSORY HEARING**

The sense of hearing is important not only for playing instruments, but also to interact with humans through speech. In the future, robots will be able to follow verbal commands and, maybe one day, have a meaningful conversation.





**\_BRAIN**

The HUBOs are controlled by two computers, each about as powerful as a netbook. But unlike people, these robots keep their brains in their chest. The head is mostly empty, leaving room for additional sensory equipment like cameras and microphones.

**\_CAMERA SIGHT**

Robots can use cameras as their eyes to see the world. HUBOs come with a single low-resolution camera mounted in the top of their head, but researchers are free to change the camera or add more if they wish.

**\_REFLECTIVE PLASTIC**

The visor is made of a black reflective plastic, hiding the contents of the head from view and giving the robots a look reminiscent of astronauts. A display placed directly behind the visor, such as an iPhone installed in the robot's head, can be seen through the front of the visor and used to provide visual interaction and expression.



hubo



"There are computer programs that write music—very, very good music—that could pass for something by Mozart or Bach," Kim says. "Because we have robots that can build things much faster than we can, maybe we'll be able to program them to do things creatively to a greater extent."

He says involvement with the robots has spanned beyond the two labs. Yuri Gogotsi with the A.J. Drexel Nanotechnology Institute has helped develop new power systems for the robots, and William Regli, a professor of computer science in The iSchool at Drexel, has helped with the development of capabilities software.

"It really does require a wide variety of skills," says Kim, who received dual undergraduate and graduate degrees in both engineering and music, as well as a Ph.D. from the MIT Media Lab.

"I think my students would [agree] that a lot of what they learned with working with the robot has not come from the classroom—it's being able to be hands on and tinker around with the robots," Kim says.

When Jaemi first arrived at Drexel, she spent most of her time in the DASL lab, where Oh and his colleagues gathered knowledge about the basic functions and quirks of the HUBO design. As MET-lab and DASL researchers began to discuss potential collaborations, Jaemi's schedule became busier than ever.

"It's similar to the early days of computers, when there were only a few in the world," Kim says. "If you were at a university that had one, you would get some time on the computer at, say, 3 in the morning to try to get your work done before someone else gets on at 4:30. It was kind of like that—everyone wanted a turn with Jaemi."

But with increased collaboration came more interesting projects. A student in the DASL lab was interested in creating a program that would allow Jaemi to watch a conductor and be able to follow the beat—a project that led to developing "music understanding" programs for humanoids.

"It's a dancing program, essentially," Kim says. "It hears the music, figures out where the beats are and then can move in time with the beat. The movements are pretty limited right now, and a lot of that has to do with us being afraid to make them do really crazy motions really fast—we have to be really careful with them. It's about baby steps."

#### A FUTURE UNDEFINED

While the robotics research at Drexel garnered accolades and interest from engineers all over the world, Kim says reactions from those outside of the engineering field aren't always as positive.

"Everybody asks me if robots are going to replace humans in certain jobs, particularly when it comes to the arts. And oh God, I don't want to see robot musicians or robot dancers," Kim says.

He says he never thinks of the robots as a way to replace human functions, but rather, as a tool to help further explore current fields.

"I want to see humanoids become useful assistants, to be able to do the things that we can't do or don't want to do," Kim says. "Something as simple as taking out the garbage or doing the dishes, but also the really hazardous things, like dealing with nuclear power plant disasters or space exploration."

But Kim thinks that humanoids could eventually play a crucial role in expanding fields that traditionally have never used mechanical assistance.

"Robots are tools that could help us understand better what we do, what is unique about being human," Kim says. "It's a tool for us to understand what goes into a great musical performance."

"You can't say to a piano player, 'Play that again, but use .1 more Newtons of vertical force. No one can do that. I can play it louder, I can play it harder, but I can't vary myself that precisely,'" Kim says. "But a robot can. Just by trying to teach a robot to play like a human, we can learn a lot more about how we do it ourselves as humans."

While rhythmic humanoids might be a little too reminiscent to the robotic uprisings in "The Terminator" and "I, Robot," Kim says the fear others have of the future of robotics is a little less literal and more philosophical.

"We hold onto these romantic ideals about what's human. We used to think a robot would never be able to play chess or Jeopardy better than a human. We were wrong, and I don't think we need to be afraid of those things," Kim says. "Just because a calculator can do multiplication faster than I can doesn't make me feel like I have less self worth. The fact that we as humans can conceive of machines, build them and use them is one of the amazing things about being human."

"For these HUBOs, that's still a long ways off. For now, we're just happy to help them stand up straight and bounce to a beat."

*"Robots are tools that could help us understand better what we do, what is unique about being human. It's a tool for us to understand what goes into a great musical performance."*





## \_ABOUT DREXEL

**APPLIED\_BEAUTY**

Located in Drexel's new Papadakis Integrated Sciences Building, the biowall, pictured above, is a 22-foot wide, 80-foot tall functional wall of plants that purifies the indoor air. It is North America's largest living biofilter—and the only such structure installed at a U.S. university.

**F**OUNDED IN 1891 in Philadelphia, Drexel is a top-ranked, comprehensive university recognized for its focus on experiential learning through cooperative education, its commitment to cutting-edge academic technology and its growing enterprise of use-inspired research. With more than 24,500 students, Drexel is one of the nation's largest private universities.

Drexel is a leader in creating technological solutions to societal problems of the 21st century. The University's research enterprise has increased expenditures for sponsored projects from \$15 million in 1996 to approximately \$110 million today. Drexel is committed to use-inspired research and is poised to respond to novel opportunities for research, scholarship and technological development. Examples include interdis-

ciplinary efforts to meet emerging national imperatives to upgrade the transportation infrastructure, to move "alternative" energy sources into the mainstream and to improve medical care while reducing its costs.

Drexel's 74-acre University City campus is located in the vibrant University City district of Philadelphia, Pa., which is the nation's fifth largest city. The campus is a 10-minute walk from Center City, the core of Philadelphia's commercial and business district. Drexel teaches at four additional locations: the Center City campus for the the College of Nursing and Health Professions and the School of Public Health; the Queen Lane campus in East Falls for the College of Medicine; the Drexel at Burlington County College campus in Mount Laurel, N.J.; and the Center for Graduate Studies in Sacramento, Calif.

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