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LEHIGH RESEARCH REVIEW

SCHOLARSHIP, DISCOVERY &
THOUGHT LEADERSHIP

LEHIGH RESEARCH REVIEW

VOLUME NO. 2, 2017

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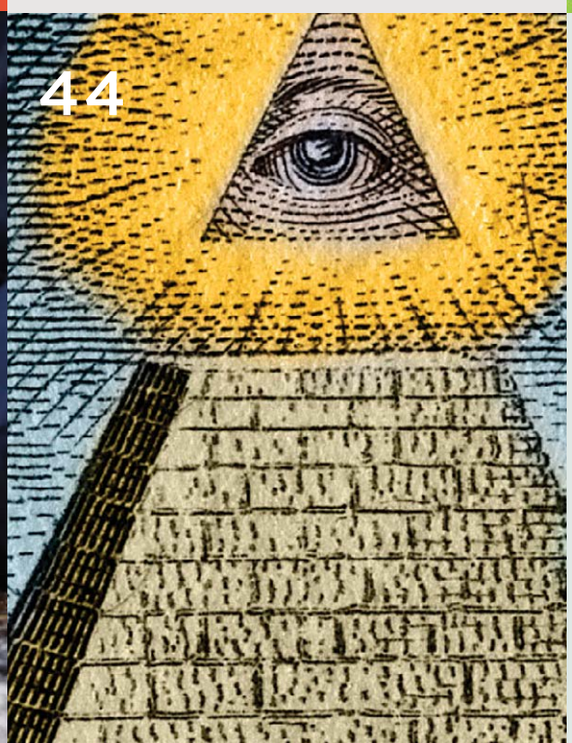
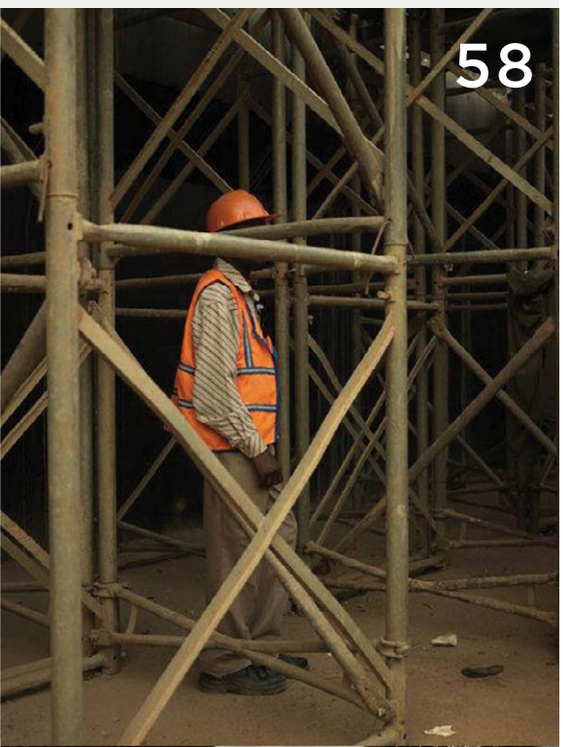




INNOVATING & ADAPTING

Lehigh University has produced some of the world's greatest innovators, inventors and thinkers. A pioneering tradition has permeated our campus and our culture since our founding, and although the world has changed dramatically in the more than 150 years that have passed since, that spirit of discovery remains central to the Lehigh ethos.

We are all here to learn. And we understand that, in order to truly learn, we must first be willing to embrace the challenge of the unknown.

As we seek to answer the most pressing questions of our time, we must forge ahead into new territory, create novel pathways of discovery and test our assumptions. If one approach fails to lead us to new knowledge, we must try another, and then, if necessary, yet another—always evolving, always questioning, and always building on the contributions of the scholars who came before us.

"IN ORDER TO TRULY LEARN, WE MUST FIRST BE WILLING TO EMBRACE THE CHALLENGE OF THE UNKNOWN."

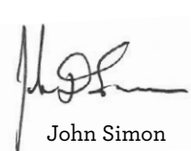
We constantly adapt. We look at the needs of the world around us and work diligently to meet them. We expand the skills we already possess and strive to develop new ones.

We learn. And as we learn, we change.

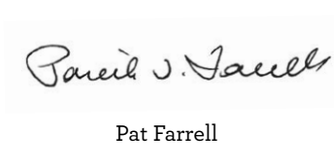
Today, Lehigh stands on the precipice of a bold new future. In the fall of 2016 we outlined an ambitious initiative: a significant expansion of our faculty and our graduate and undergraduate student populations, an extensive plan to build cutting-edge new science and research facilities, and a commitment to leverage some of our greatest strengths to launch a new college of health. This bold step forward will, of course, bring substantial change to our campus, and that change will inevitably push us out of our comfort zone. But we also believe this evolution will help us build a stronger, more nimble, more dynamic Lehigh—a university fully capable of taking on the challenges of a still undefined and uncertain future.

In this issue of the *Lehigh Research Review*, you will read about just some of the research and scholarly activity that we believe is already changing the world for the better. We take great pride in our faculty's work, which embodies the creative and purposeful spirit of this university. We hope you enjoy learning from them just as much as we have.

Sincerely,



John Simon
President



Pat Farrell
Provost

Collecting Ideas

Lehigh University Art Galleries boasts a collection of more than 14,000 pieces.

Leysis Quesada Vera
Cuban, b. 1973
Los Sitios, 2015
Color photograph
Gift of the artist

Willie Cole
American, b. 1955
Home and Hearth, 2011
Silkscreen, 30/75
Gift of Lafayette College in honor of the Experimental Printmaking Institute

ART

THE ART OF COLLECTING

Ricardo Viera and his team at the Lehigh University Art Galleries teach and inspire with a visual laboratory of world-class works.

Lehigh University Art Galleries' current exhibition, "The Art of Collecting," features works by Henri Matisse (above), and Andy Warhol (bottom right).

Written by **Kelly Hochbein**

Images courtesy of **Lehigh University Art Galleries**

When Ricardo Viera arrived at Lehigh in 1974, the university's art collection included around 2,500 pieces. Today, Lehigh University Art Galleries (LUAG), the university's teaching museum, boasts a collection of more than 14,000 pieces. Viera, a professor of art and director-chief curator of LUAG, has also established a nationally recognized collection of Latino and Latin American photography and video at the museum, thanks to his expansive network of artist relationships.

His passion for art is obvious in both his demeanor and the exhibitions he oversees. But Viera becomes particularly enthusiastic when he speaks about the educational aspect of LUAG's work.

"We don't collect objects. We collect ideas," he says. "We are not here to preach one thing, to interpret things one way. We are here to expose [people] to things that in our judgment have a certain kind of quality."

That quality is on display in a current exhibition titled "The Art of Collecting," located in four of LUAG's campus galleries. It features works by Henri Matisse, Georges Braque, Pablo Picasso, Georges Rouault, Henri Cartier-Bresson, Camille Pissarro, Irina Ionesco, Luis Gonzáles Palma, Joel Meyerowitz, Andy Warhol, and many others, all acquired by the museum between 2011 and 2016.

The LUAG team hopes that exposure to such a wide variety of high-quality art will serve as a launchpad for meaningful thought and conversation among students, faculty, staff and members of the surrounding community. Faculty members utilize the museum to teach a wide range of topics from art history and poetry to psychology and anthropology.

"The collection is relevant to just about any department on campus," says Mark Wonsidler, curatorial associate for exhibitions and collections. "We're always trying to get outside the reputation of being decorators, which is not what we're doing. It's education, not decoration."

The amazing thing about art, says Viera, is that there are many different ways of looking at it.

"You just need a point of entry," says Patricia MacAndrew, coordinator of visitor services and museum education. "It's a way of connecting you with the whole history of humanity."

Wonsidler agrees: "The museum is a space where several people can stand in front of the same artwork and talk about it. The stakes are different than they would be arguing in a political science course or something like that. There's a possibility of coming together in a certain way to learn how to talk about something you're seeing and feeling. That can build bridges between people who are trying to understand. Every object is a jumping-off point into a world, into a conversation, into a philosophy."

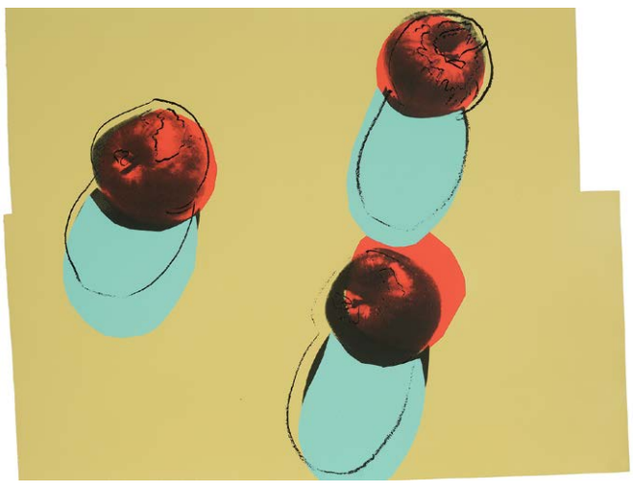
The museum has extended that conversation into the larger community through an accessible art program for low-vision visitors that includes audio descriptions and tactile diagrams. The main gallery hosts study nights at the museum, providing a unique space for students during final exams.

Art is an opportunity to provide students with a rich learning experience, says Lehigh trustee Anne Kline, chair of the cultural affairs subcommittee.

"The university's remarkable collection, and our distinctive efforts to use it in a teaching capacity, allow us to raise awareness of the Arts one painting, one photo, or one sculpture at a time," Kline says.

Viera likens their work to that of a nutritionist, fully aware that not all art is for everyone, but that the experience has great value.

"It's up to you. If you like rice, you like rice. If you don't, you don't. There are people who like abstract art, there are people who don't. There are people who grow and learn to love it. Basically we do something that we have a passion for. Not everyone shares our enthusiasm. Therefore, we welcome those who have passion, but [for] those who don't, we try to expose them to the finest, to the best, to the most nutritious kind of art that we can find. And that is what we do here."

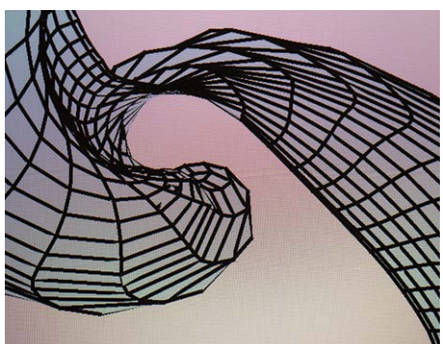


Ricardo Viera holds a diploma from the School of the Museum of Fine Arts, Boston; a BFA from Tufts University; an MFA from Rhode Island School of Design and a Certificate of Museum Management from the University of Colorado Museum, Boulder.

MECHANICAL ENGINEERING & MECHANICS

A BIO-INSPIRED FUTURE

Keith Moored's work to unlock the fluid mechanics of schools of fish may lead to efficient, autonomous underwater vehicles with the unprecedented ability to perform tasks as a team.



Written by
Lori Friedman

It is easy to speculate why fish might swim in schools—better protection from predators, improved foraging capability, easier fish-to-fish communication. Yet, none of these reveal why fish move together in a specific pattern.

Research on the energetics of schools of fish offers counter-intuitive data—the group patterns do not necessarily maximize energy use.

Then why do they do it? Keith Moored, assistant professor of mechanical engineering and mechanics, believes that fluid-mediated forces are at work. In fact, his previous research has pointed to its likelihood.

"The 3-D formation created by a group of fish is akin to atoms being pulled by forces into a lattice structure," says Moored.

A comprehensive understanding of these collective interactions could help scientists determine how fragile biological networks are to overfishing, loss of habitat and a changing climate. It could also open the door to the development of schools of bio-inspired technologies.

Currently, unmanned underwater vehicles are used to assist in commercial fishing, for water sample collection, in search and rescue operations and for military purposes.

In the future, says Moored, instead of just one, it is likely that a group of devices will be sent underwater to perform a set of tasks as this collective approach is much more efficient. But there are obstacles.

"The key to making a breakthrough in the design of high-performance collectives of bio-inspired devices is to understand the fundamental fluid mechanics of collective interactions," says Moored. "But right now we don't have a thorough understanding of the fluid dynamics between fish in schools."

Moored has received a National Science Foundation CAREER Award to explore this promising area of inquiry. He will use the funds to gain a better understanding of flow mechanisms that occur among unsteady (due to oscillating fins), three-dimensional interacting bodies in complex arrangements.

Ultimately his work could answer the question: What can scientists borrow from nature to achieve teams of aquatic vehicles as optimized for underwater movement as fish swimming in a school?

One of Moored's first objectives is to characterize the forces, energetics and flow physics of collective locomotion for various arrangements typical of animal locomotion.

With extensive experience developing fluid dynamic testing facilities, he will use a low-speed wind tunnel facility and two pitching wings—wing models that can mimic the tail oscillations of a fish. The wings will be arranged in various configurations and subjected to a number of flow conditions.

Moored will characterize the flow fields among interacting pitching wings using a stereoscopic particle image velocimetry system which is designed to obtain instantaneous velocity measurements and related properties in fluids. He will also use a six-axis force and torque sensor which can take six simultaneous measurements.

"Essentially, my team and I will attach the sensor to the pitching wing model and it will sense all of the forces acting on the wing, including the thrust and drag," says Moored.

These quantification studies will constitute the first time such detailed measurements of the forces, energetics and flow fields of three-dimensional thrust-producing interacting bodies in such complex arrangements have been assembled.

Using the same experiments, Moored will also examine his hypothesis that the lattice-like arrangements seen in schooling arrangements in nature may be due to fluid-mediated forces.

In previously published work, Moored has shown that a stable equilibrium distance—a state in which a body tends to return to its original position after being disturbed—exists between two interacting pitching wing models in a side-by-side arrangement. He found that equilibrium was stable for air or water flow disturbances in the cross-stream direction.

"THE 3-D FORMATION CREATED BY A GROUP OF FISH IS AKIN TO ATOMS BEING PULLED BY FORCES INTO A LATTICE STRUCTURE."

"If one swimmer moved away from the other, a fluid-mediated force would pull them back together and vice versa," says Moored.

By probing variations of position he will determine whether the location he previously identified or others like it are truly stable equilibria in three dimensions.

Such a force map could transform scientists' understanding of schooling behavior—an important step toward a fuller understanding of group behaviors in biology and a major development in underwater vehicle design inspired by nature.

Keith Moored's research interests include bio-fluids and mechanics, bio-inspired engineering and fluid-structure interactions. He received his Ph.D. from the University of Virginia and completed his postdoctoral research at Princeton University.

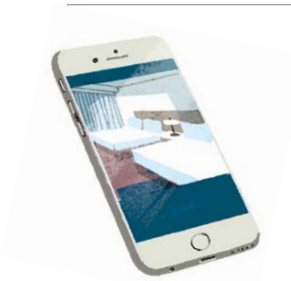
Borrowed from Nature

Moored seeks to understand the flow mechanisms that occur among unsteady, three-dimensional interacting bodies in complex arrangements.

MANAGEMENT

EXHAUSTED BY EMAIL

Liuba Belkin's research suggests that after-hours work email expectations negatively impact employees' ability to detach from work.



According to Belkin's research, even the perceived expectation of after-hours email can lead to employee burnout.

Written by
Kelly Hochbein

Illustration by
Tatsuro Kiuchi

France rang in 2017 with some new labor laws, including the "right to disconnect."

Companies in France with more than 50 employees must now determine the hours—typically evenings and weekends—when employees are not permitted to send or respond to emails, giving French citizens the legal right to ignore work emails outside of typical working hours. This right could help improve French employees' emotional health and work-family balance, according to research by Liuba Belkin, associate professor of management.

In a study she co-authored with William Becker of Virginia Tech and Samantha A. Conroy of Colorado State University, Belkin found that the organizational expectation for employees "to be available during non-work hours has a powerful influence on employee depletion due to the inability to detach from work." In other words, if an employer expects after-hours availability via email, the employee is more susceptible to "burnout."

The paper, titled "Exhausted, but Unable to Disconnect: The Impact of Email-related Organizational Expectations on Work-Family Balance," details the findings of a survey the team administered to 297 working adults. Participants answered questions related to organizational expectations regarding off-hour emailing. The team then performed a complex analysis using structural equation modeling, controlling for all demographic variables. The time-separated data revealed that "organizational expectations are positively related to the time spent after hours on work-related emails, low work detachment and employee emotional exhaustion that, together, hinder work-family balance."

"We measured how many hours per week [employees] actually spend on email after hours and we found it was an average of eight hours a week—another working day," says Belkin. "So people technically work six days a week or more. They just don't notice."

It is not, however, the actual amount of time spent on email that causes stress, says Belkin; rather, it's how much time employees think they're supposed to spend. So even if employees avoid checking their email after hours, the belief that they are expected to do so does not allow them to detach from work, which leads to higher levels of emotional exhaustion, regardless of the actual time spent on work emails after-hours. These perceptions might stem not only from organizational policies, but also inadvertently from observed managerial behaviors (such as sending an after-hours email without specifically stating that immediate response is not required) or from self-comparison to colleagues who consistently work after hours and "force people to actually spend more time on work," says Belkin. "That's why they feel exhausted, regardless of whether these are official or informal norms in an organization."

Fifty-five percent of study participants reported difficulty detaching from work and only 8 percent reported having no problem doing so. Belkin and her colleagues also found that high-segmenters, those who prefer to separate work from non-work related activities, are more damaged by high expectations of after-hours email than low-segmenters, who are more flexible in their work schedules. But "even low-segmenters feel exhausted. So at the end of the day it gets to everyone," says Belkin.

Belkin and her colleagues are conducting a follow-up study to examine the impact of both formal and informal norms on work-family balance.

In the initial study, 65 percent of participants believed their company had high expectations to monitor after-hours work emails. The follow-up study uses three separate surveys to measure employee perceptions, actual company expectations and the observations of significant others. Managers are told that an anonymous employee will be completing the survey and are asked to provide their formal expectations for after-hours email as an objective measure. The team has also added measurements in terms of emotional strain to more precisely measure work-family balance.

The follow-up survey was inspired by personal feedback Belkin received following the extensive media coverage of the team's initial work. A number of individuals wrote about the effects of work-email exhaustion they have observed in their significant others.

"[Significant others were] saying how they're also affected by it," says Belkin. "If we talk about work-family balance, we should look at the other side, too."

Powerful Gratitude

Belkin, whose doctoral dissertation focused on how emotions are transferred over email, also examines how different positive emotional expressions affect the behavior of others in negotiations.

Along with Tony Kong, assistant professor of management at the University of Houston, Belkin is exploring in particular the impact of gratitude. She and Kong have found that people can reap relational and economic benefits by expressing gratitude to others in a negotiation. Expressions of gratitude (as opposed to neutral or angry expressions) increase perceptions of the expresser's benevolence and motivate negotiation partners to be more prosocial, sharing more and increasing willingness to continue the relationship with the emotion expresser.

"[Gratitude] is the emotion that evokes prosocial motivation in self and others and willingness to help," says Belkin. "We hope to find something interesting and really useful to society, too, in terms of making things a tiny bit better."

Liuba Belkin's primary research interests focus on affect and emotions in organizational settings and the role of emotions in trust relationships and managerial practices. She also studies the influence of electronic communication media on employee relationships, decision-making and performance. Belkin received her M.B.A. in marketing and management and Ph.D. in organizational behavior from Rutgers University.

COMPUTER SCIENCE

QUANTIFYING CREATIVITY

Big data can present limitless possibilities. Ting Wang uses it to study the phenomenon of creativity in scientific enterprise.

Creativity has long been an intangible concept, says Ting Wang. The complex process of connecting two seemingly unrelated scientific ideas is difficult to understand.

"It's kind of magic," says Wang, assistant professor of computer science and engineering. "How are you connecting these two thoughts?"

Wang has a possible answer to that question that's both creative and concrete: He's using big data to better understand the underlying mechanisms of the creative process.

An understanding of the creative process might be helpful for those working on target innovation.

Written by **Kelly Hochbein**

Illustrations by **Zim&Zou**

Until now, researchers studying creativity in the scientific enterprise have focused on the references of scientific publications to gain an understanding of how the publications relate to one another. A paper's creativity, therefore, has been measured by examining how it connects previously disconnected knowledge. The greater the difference between the idea presented in a new paper and the claims made by the works cited within it, the more creative the new idea.

However, this approach doesn't reflect a complete picture of how the authors actually write the paper, says Wang. The authors consumed and possibly have been inspired by information outside the publications they've referenced, he says. "That information would be critical to understanding the novelty or the creativity of those who published the paper because it reflects how we take information and how we digest it and how we actually produce something new."

In a paper titled "Inspiration or Preparation? Explaining Creativity in Scientific Enterprise," Wang and his colleagues—Lehigh doctoral student Xinyang Zhang and Dashun Wang, associate professor of management and organizations at Northwestern University's Kellogg School of Management—explain an approach that allows them to "quantitatively assess the creativity of a paper, an author, an institution or even a discipline" for the first time. They also develop a predictive framework that "accurately identifies the most critical knowledge to fostering target scientific innovations." Zhang presented the paper at the International Conference on Knowledge Management in October.

MAKING THE JUMP

In defining the creativity of an idea, Wang and his colleagues consider two factors: its rarity, or how many others have taken a similar approach, and the disconnect between the idea in the paper and the papers it cites. How big was the jump from an existing idea to the new idea?

To find out, the team looked to information consumption. The most comprehensive dataset that captures information consumption in scientific enterprise, they write, is the web traffic generated by researchers, which reveals what online resources they access. Wang and his colleagues used two web-scale, longitudinal datasets—Indiana University Click and Microsoft Academic Graph—to contrast authors' information consumption behaviors (input) against published scientific papers (output).

The Indiana University Click dataset is an anonymized dataset comprised of 53.5 billion web requests initiated by researchers at Indiana University between September 2006 and May 2010, and the Microsoft Academic Graph (MAG) dataset consists of 120.9 million papers published in 24,843 venues across all scientific fields. After identifying in the MAG dataset all papers published from 2007 to the present with at least one Indiana University-affiliated author, the team correlated the two datasets.

"You have input and output, and we try to find the corresponding part. Then you can sort of figure out what input leads to what output, how big the leap was [from one idea to another]"—or, in other words, the level of creativity of the publication, says Wang.

Due to privacy and technology constraints, the team could not track information consumption and knowledge production at an individual level. They were, however, able to study correlation at an organization level and found "remarkable predictability in creative processes": Of 59 percent of papers across all scientific fields, 25.7 percent of their creativity could be readily explained by their potential authors' information consumption.

SPEEDING UP THE PROCESS

An understanding of the creative process can potentially provide a valuable tool to streamline that process, filtering out useless information and focusing on the most critical pieces. With that in mind, the team leveraged their findings about predictability to develop a predictive framework.

"We are kind of buried in this sea of infor-

Ting Wang directs the DataPower Lab (DPL) at Lehigh. He is the recipient of a major innovation award for "Big Data Analytics for Cybersecurity" from IBM and received his Ph.D. from Georgia Institute of Technology.

mation," says Wang. "So when you want to do something, the first step is to see what others have done. Particularly if you're doing very cutting-edge research and the frontier is so large, there are a lot of related works. You are aware or maybe not aware [of those works]."

The team's framework, says Wang, can reveal the next step a researcher should take and speed up the creative process.

"If we understand how you make the jump from one thought to another, eventually a machine or an algorithm [can be created] to recommend a lot of information, saying 'this is one piece of information you might want to look at,'" he explains.

This could be especially valuable for those working on target innovation and is not limited to scientific enterprise.

"Indeed," the team writes, "[our framework's] mechanistic nature makes it potentially applicable for describing creative processes in other domains as well, such as musical, artistic and linguistic creativity."

CREATIVE DIFFERENCES

Wang and his colleagues also found diversity in the creativity phenomenon of different academic disciplines. They compared biology and computer science specifically.

Reference pairs for publications in biology, Wang says, tend to be close together. These small steps occur, he says, because biology is a more established, risk-averse discipline resting on a large amount of existing work. In fact, he says, ideas with higher levels of creativity may not be as well received in the biology community due to its more conservative tendencies.

Computer science, on the other hand, tends to link diverse, more difficult-to-connect ideas. "Computer science has a little more room for risk [because] it won't lead to any consequential results," says Wang.

Therefore, Wang explains, papers in computer science demonstrate higher levels of creativity: "One can observe that biology follows a lognormal distribution, while computer science apparently follows a bimodal distribution, peaking at both low and high creativity scores. Such phenomena may be explained by that compared with biology, computer science is a relatively 'engineering' discipline, featuring more frequent fusion of originally disconnected knowledge."

RISK VS. REWARD

Wang, who runs the DataPower Lab at Lehigh, works on "both sides of data mining." He conducts research that invents new concepts and methods that empower large-scale data mining, and his work also bridges disciplinary boundaries for the application of these advances to privacy, security and trust issues. Prior to his arrival at Lehigh, Wang worked as a security analyst at IBM's Thomas J. Watson Research Center, where he wondered if analyzing web traffic might reveal to an outsider the company's research activity. This eventually led to his work on creativity and information consumption. Privacy, he says, remains a concern in this research.

"WE ARE KIND OF BURIED IN THIS SEA OF INFORMATION," SAYS WANG. "SO WHEN YOU WANT TO DO SOMETHING, THE FIRST STEP IS TO SEE WHAT OTHERS HAVE DONE."

"On the positive side, I try to understand complex societal, technological, and business phenomena using massive amounts of data," Wang explains. "On the negative side, I see how such big data approaches break privacy, safety, transparency."

Recalling his work at IBM, Wang notes the concerns a private-sector company might have with this use of data.

For example, researchers are not permitted to search a patent database, he explains, because narrowing the scope of a search and focusing on a particular type of patent can enable a competitor to determine the specific patents a company is going to file, putting that company at a disadvantage.

In a nonprofit environment like a university, these concerns still exist, and discussions about them are becoming increasingly more important. Any potential risk, though, is weighed against its reward.

"I think we are in a time where huge amounts of data give us lots of possibilities, and these things can only happen at this moment because previously we didn't have this kind of data available," says Wang.

Still, says Wang, data is limited when it comes to creativity. Researchers generate ideas from many sources—conversations with colleagues or print copies of books, for example—and those sources cannot be captured using the dataset he and his colleagues used for this study. However, this "may be an important step towards a better understanding of this creative process," he says.

SCHOOL PSYCHOLOGY

HOW QUICKLY DO PRESCHOOLERS LEARN?

Children develop language and literacy skills in preschool. Robin Hojnoski aims to develop measures to screen preschoolers' literacy skills and give teachers tools to boost support.

Hojnoski and her team explore measures to assess preschoolers' grasp of beginning sounds.

Written by **Mary Ellen Alu**

Illustration by **Michelle Thompson**

How quickly do preschoolers learn vocabulary, beginning sounds, rhyming and concepts? Is it possible to evaluate their growth? If so, how frequently should educators measure preschoolers' literacy skills so that instructional changes can be made?

"We don't know," says Robin Hojnoski, associate professor of school psychology. "This is what we're trying to figure out."

Collaborating with researchers at the University of Minnesota and the University of Washington, Hojnoski is helping to develop measures to monitor literacy progress among preschoolers and ways for teachers to use the assessment data to assist students. The four-year study is funded by the Institute of Education Sciences (IES).

"If we think about the investment that we make in preschool education, we want to make sure that we're focusing our efforts on building children's skills in important areas," Hojnoski says. While there are many reasons preschool matters, she says, one is "to build children's language and literacy skills so that they have the foundation for moving into kindergarten and being successful."

Hojnoski and graduate assistant Elizabeth Boyd began by creating more measures for monitoring literacy skills and assessing which ones would work well across family income levels and regions of the country. A picture of skis, for example, would not necessarily be a good universal measure for assessing vocabulary skills, she says, since preschoolers in regions without snow might less likely be able to identify what they are.

The team also worked on measures to assess preschoolers' grasp of beginning sounds—pairing photos of a rock and a mouse, for example, to identify a word with the "mmm" sound. The measures will be narrowed down through a statistical process, Hojnoski says, allowing the researchers to develop tools for evaluating small changes or growth in literacy over time.

In January, Lehigh began testing 85 preschoolers on iPads to assess which of the measures worked best and at what pace preschoolers were learning. Lehigh is working with children enrolled in Berks County (Pa.) Intermediate Unit programs, such as its Head Start classes, childcare programs and preschool classrooms.

Once effective tools for measuring literacy skills are determined, Hojnoski says, the researchers will focus on developing ways for teachers to use the data to assess who needs more instructional support, in what areas, and how best to provide the additional instruction. The researchers want to develop platforms that would outline activities for strengthening skills in particular areas.

"It's one thing to know that a child isn't making as much progress as another child," Hojnoski says. "Now, what should be done? And actually, kids who are behind have to make more than adequate progress. They have to make extra [progress] to be able to catch up with other kids."

Hojnoski acknowledges the lingering debate in some circles over the appropriateness of teaching early academic skills to preschoolers, regardless if it's literacy, science or math, rather than just allowing them to play.

"We're the ones who create the false dichotomy between the two," she says. "I think kids just love to learn. And so, why would you not teach them? Creating instructional activities that provide an enjoyable experience and meaningfully engage kids allows them to both play and learn." ●

Robin Hojnoski's research focuses on the application of school psychology principles and practices to early education. She is particularly interested in early identification and prevention and intervention for learning and social behavior. Hojnoski received her Ph.D. from the University of Massachusetts, Amherst.

How Helpful?

Some criticize "voluntourism" as a self-serving exercise of condescending and unprepared volunteers who lack an understanding of the social and cultural circumstances in which they hope to serve. Lasker examines how organizations can provide effective, responsible and ethical programs that offer real, lasting benefits to host communities as well as to volunteers.

GOOD INTENTIONS, GOOD WORKS?

Judith Lasker writes what the New York Times *calls a "best-practices manual" for short-term volunteer trips, a growing phenomenon that has sparked both support and criticism.*

Every year, says Judith Lasker, as many as a million Americans travel to developing countries hoping to help less fortunate people by giving of their time, their energies and their talents.

These volunteers represent businesses and nongovernmental agencies, churches and nonprofits, hospitals and universities. Some work in medical clinics and orphanages, some build schools and drill water wells. Some pick up college credits, and some spread the gospel of their faith. Even tourist agencies are sending people on international service projects. The phenomenon has given rise to a new word: "voluntourism."

"Nearly every time I mention my research," Lasker writes in her most recent book, *Hoping to Help: The Promises and Pitfalls of Global Health Volunteering*, "someone has a personal experience to recount or tells me about a family member or close friend who has volunteered. That was not the case only a decade ago."

A debate has sprung up over the motives and effectiveness of international volunteers. Supporters say volunteering can benefit the lives of volunteers as well as the people they help. Critics say some programs are culturally insensitive and self-serving, lack preparation and follow-up, and can have negative economic and health effects on host communities.

"The developing world," Somalian blogger Ossob Mohamud wrote in *The Guardian* in 2013, "has become a playground for the redemption of privileged souls looking to atone for global injustices by escaping the vacuity of modernity and globalization."

Mohamud elaborated: "Voluntourism almost always involves a group of idealistic and privileged travelers who have vastly different socioeconomic statuses vis-à-vis those they serve. They often enter these communities with little or no understanding of the locals' history, culture and ways of life."

"'Voluntourists' they may be," countered Sam Blackledge, a reporter for England's *Plymouth Herald*, "but their work can have a huge impact on their own lives and the lives of those they help."

Blackledge added a proviso: "No approach is without its flaws, but it is vital that people do not group charities doing this well with companies who are putting very little into the developing world. Charities that invest in the developing world need keen, energetic, ambitious people to help them along."

How can international volunteers serve effectively, and know they are doing so? How can they turn good intentions into good works while avoiding the appearance of condescension? Lasker, the National Endowment of the Humanities Distinguished Professor of Sociology, attempts to answer these questions in her book.

"Although short-term international volunteering is a massive and growing enterprise," she writes, "there is very little information about what volunteers do, where they go, who is sponsoring them, and what they accomplish."

Written by **Kurt Pfitzer**

Illustration courtesy of **Barbie Savior**

Judith Lasker's research interests include global health; women's health issues, especially related to pregnancy loss and infertility; the impact of chronic disease and loss; and community needs assessment and evaluation research. She received her Ph.D. from Harvard University, and in 2014 was awarded the Centennial Medal by the Graduate School of Arts and Sciences at Harvard.

"Many scholars have discussed the theory behind global aid and the various perils in its execution," said a review in the *New York Times*. "Dr. Lasker... delivers instead a straightforward, data-driven review of a small health-related fraction of the enterprise... Anyone contemplating a volunteer stint is likely to be interested in [her] results, which amount to a sort of de facto best-practices manual."

Her primary concern, she says, is "whether the investment of billions of dollars of resources in the short-term volunteering enterprise can be justified by the results in terms of improvement in health, reduction in health disparities, or other measures of value to the host communities.

"I hope to contribute to making [volunteering] more effective and valuable to all concerned."

A LIFE-CHANGING EXPERIENCE

In conducting research for *Hoping to Help*, Lasker and her assistants interviewed 119 people: 55 host-country staff members in Ecuador, Ghana, Haiti and Niger, 15 volunteers, 27 officials with American sponsor organizations, 15 people from the United States and France who work full-time with volunteers in host countries, and seven global health experts.

The group also conducted an online survey of 177 U.S. organizations that send volunteers overseas for short-term health programs. And they collaborated with the Catholic Health Association on a survey that received responses from 152 organizers of short-term medical missions and 205 volunteers who served with the missions.

Four of Lasker's former students played key roles in the research: Ana Arteaga '12, now a pre-med graduate student at Hawaii Pacific University; Sirry Alang '08G, assistant professor of sociology at Lehigh; Joe Rendon '14 '15G, an education specialist with AgSafe; and Caroline Kusi '11, the East Africa coordinator for the University of California at San Francisco's Preterm Birth Initiative in Rwanda.

Arteaga spent three weeks with Lasker in Haiti and interviewed several dozen Haitians about the effectiveness of international volunteers. Her work in Haiti, she says, changed the course of her life.

"The experience rocked me to my core. It was horrifying to see how people just a short flight away from the United States could live such radically different and impoverished lives. After Haiti, I knew I had to get into the medical field. It wasn't just a passion for medicine that arose, but an overwhelming desire to provide physical relief to those who suffer."

Arteaga's advice to prospective international volunteers is to find an organization that has a long-term partnership with a host community.

"I think the focus should be on the host community and their needs, not the volunteer. It's important to understand what their needs are first and foremost, and then see if your particular skills and talents fit those needs.

"Also, if you're going to provide unskilled labor or work that could be easily done by almost anyone, I'd advise you to stay home and instead donate [your] money—I think that would be a better use of resources and time."

ON THE SCENE IN GHANA

Alang spent three weeks in Ghana, evaluating the efforts of 20 volunteers employed by a medical technology company.

At a nursing school, the company's employees sought to improve the training of nurses. At a clinic that provides maternal care and treats people with infectious diseases, the employees trained birth attendants in modern hand-washing techniques and in record keeping. They also built a medical waste disposal facility and a K-12 school.

Of all the company's efforts, says Alang, the construction of the school was the most productive.

"A group of men built the school," she says. "They had to make bricks from scratch, but after a couple of days, the volunteers figured out what to do. They worked with and learned from the Ghanaian builders. They finished the building in two weeks. Of all the volunteers, they were the ones most appreciated by the Ghanaians. And they probably had the most fun. They had a chance to get to know people and bond with them."

The efforts of the other volunteers were often undermined, says Alang, by insufficient knowledge of the Ghanaians' abilities and experiences.

The company, says Alang, "really did not know what the skill level of the Ghanaian healthcare providers was. They had not learned, before arriving in Ghana, what the people already knew.

"The volunteers did not leverage community resources. They did not pay attention to the way things were being done, especially to the resources the Ghanaians already had. The volunteers were almost dismissive of that.

"If you want to interact with a community in a meaningful way, you have to know where it's at so that you can leverage the skills and resources people already have."

The failure to appreciate and work with cultural differences was perhaps the biggest obstacle to success for the company's employees, says Alang. This became apparent during discussions about the rights of women in Ghana.

"If there's no context within another culture for people to practice certain rights," says Alang, "then there's no point telling them what rights they have. We might say to Ghanaian women, 'You have the right to go a hospital' or 'You have reproductive rights,' but a husband might not let this happen.

"Ghanaian men might think, 'These white women are coming here to tell our women to be stubborn.' These men want their wives to give birth safely, so we shouldn't treat them in a way that risks alienating them.

"If women depend on men for these things, we should leverage men's influence. Don't make it a point of contention; make it a benefit. You cannot get people to engage in things that will be beneficial to them if you bring to the process your own attitude of cultural superiority. This shows a lack of cultural humility. You have to learn about their culture and get to know people in context of their culture."

NINE TIPS FOR RESPONSIBLE VOLUNTEERING

In the final three chapters of her book, Lasker lists nine ways for international volunteers to be more effective. One recommendation is for volunteers to spend more time in host countries. Lasker says volunteers and their sponsors should also:

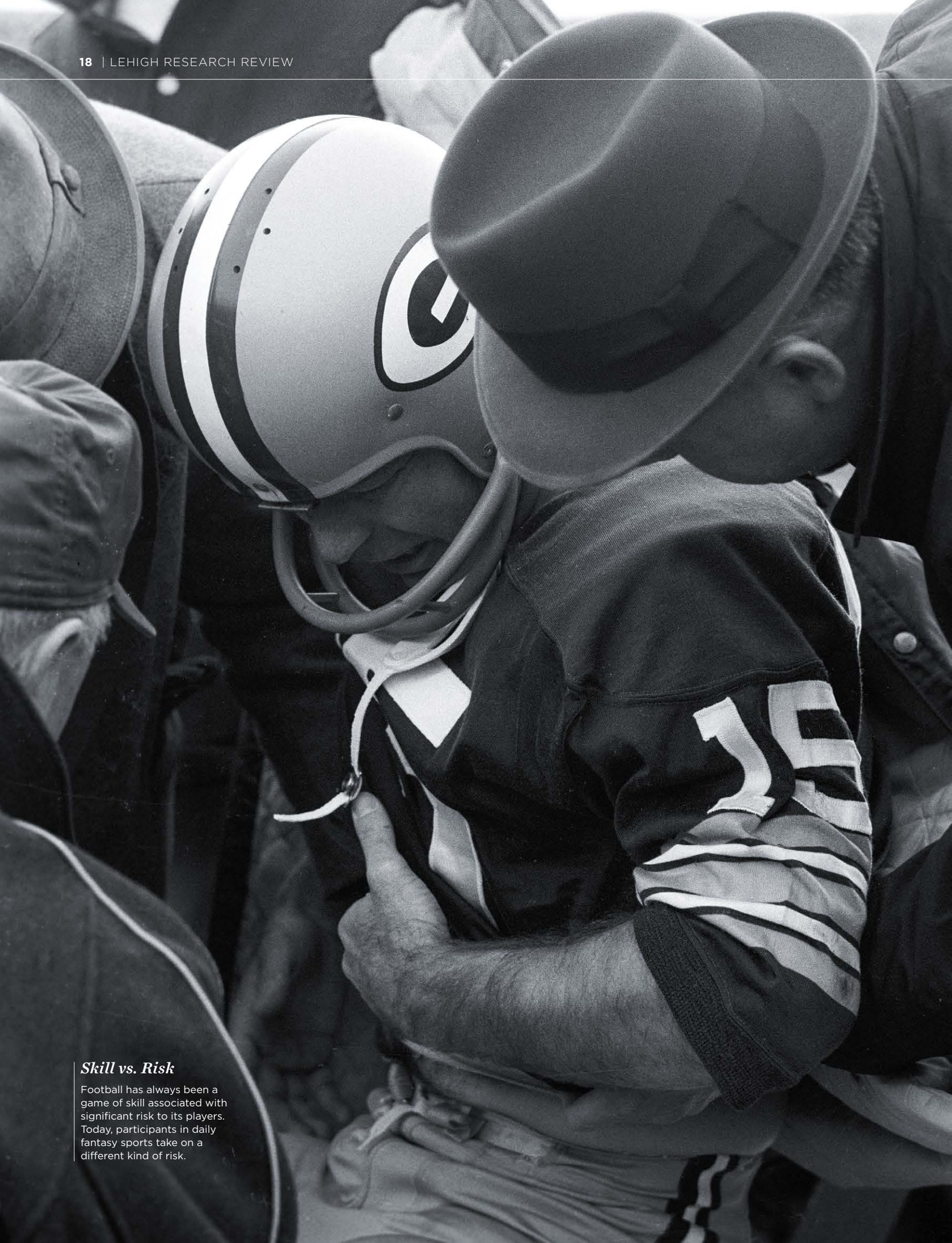
- Foster mutuality with host-country partners by regarding them as equals from whom volunteers have much to learn. Some scholars, Lasker writes, advocate "for university-community partnerships that view the community as possessing knowledge and assets, such that the university and community can work together to [create] solutions to social problems."
- Maintain continuity of programming. "A program is valuable if the results last beyond the initial visit," Lasker writes, "or if it [helps strengthen] local institutions that can continue to provide services into the future." A team of American pediatric neurosurgeons, she says, trained Peruvian surgeons during three one-week visits. The Americans then reviewed the records of Peruvian patients for five years to evaluate the success of their counterparts in Peru. "Even tracking results over time from a distance can be a valuable form of continuity," she writes.
- Seek the host community's advice in assessing the community's needs. This increases the validity of information that is gathered and improves a mission's effectiveness. Conversations should be held not just with health officials, Lasker writes, but with other community leaders and organizations as well.
- Evaluate the outcomes of their work. Lasker acknowledges the difficulty of evaluating social and educational programs and cites her own teaching career as an example. At the same time, she was surprised at the number of sponsoring organizations that had never measured the success of their efforts. She concludes that volunteer organizations should set goals, gauge results over a long period of time, and include their hosts' perspectives in their evaluations.
- Focus on prevention. While medical volunteers understandably want to cure sick people, Lasker writes, they can accomplish more in the long run by also working with hosts to tackle the causes of illnesses, from malnutrition to parasites to lack of clean drinking water.
- Offer integrated and diverse types of health services. Providing comprehensive care is more expensive and logistically challenging than offering selected types of care such as cancer screenings or simple surgeries, says Lasker, but a holistic approach, especially one that includes dental and eye care, is worth pursuing. Coordination among the providers of different specialties can make this goal easier to achieve.
- "Capacity building" has become a buzzword in the jargon of medical volunteering, says Lasker. At the least, this means the training of local staff and the construction and follow-up maintenance of labs and other facilities. Ideally, it should also ensure that volunteers not do work, such as teaching classes or interpreting, that locals can do.
- Spend more time preparing for overseas projects. Many, if not most, programs, Lasker writes, "provide grossly insufficient preparation for volunteers when it comes to the history, culture and language of the country they will be visiting." At the least, volunteers should learn the basic greetings in a country's language, something of its culture and history, and how to act "with a sense of cultural humility." Also, returning volunteers should share what they've learned with new volunteers.

In her conclusion, Lasker notes that some organizations have begun to question and even limit the number of short-term trips they sponsor. Some faith-based groups warn that "an avalanche" of short-term volunteers can reinforce a sense of dependency in a host country.

> "ALTHOUGH SHORT-TERM INTERNATIONAL VOLUNTEERING IS A MASSIVE AND GROWING ENTERPRISE," LASKER WRITES, "THERE IS VERY LITTLE INFORMATION ABOUT WHAT VOLUNTEERS DO, WHERE THEY GO, WHO IS SPONSORING THEM, AND WHAT THEY ACCOMPLISH."

Lasker says the benefits of short trips to host communities "remain to be documented more systematically," but argues that it would be "unfair to discount completely the many examples of volunteers' contributions—the thousands of individuals regaining sight or being able to work or go to school or avoiding future cancers or having pain alleviated or feeling cared about.

"The emphasis needs to be on maximizing these effects in the most responsible manner possible. In pursuit of a more just world, can we accept anything less?"



Skill vs. Risk

Football has always been a game of skill associated with significant risk to its players. Today, participants in daily fantasy sports take on a different kind of risk.

FINANCE & LAW

A FALSE DICHOTOMY

Government regulators say daily fantasy sports is a form of gambling, while the industry insists their contests are 'games of skill.' Matthew Melone says the debate is mostly irrelevant.

Daily fantasy football leagues have exploded in popularity in recent years—and government regulators have taken notice.

Written by **Tim Hyland**

On its face, it may seem to be a rather preposterous claim: According to the fantasy sports industry, their legions of customers—those football fanatics who plunk down millions of dollars each year in hopes of striking it rich on the backs of NFL stars—are not, in fact, gambling.

They are not, metaphorically speaking, spinning the roulette wheel, or testing their luck at the horse track, or directly wagering on the outcome of any particular game. Those activities, the industry says, quite clearly are gambling—and fantasy sports quite clearly are not.

For now, the courts seem content to accept that argument. But Matthew Melone wonders how long that will hold true. Melone, professor of law and finance, has in recent years undertaken an exploration into the unique and in some ways odd legal standing of so-called daily fantasy leagues, which arrived on the scene in the late 2000s and very quickly gained an extremely loyal—and surprisingly large—audience. Not surprisingly, that rapid growth caught the attention of regulators at both the state and federal levels, and attorneys general in several states soon launched inquiries into the legality of daily fantasy. But even despite these legal challenges, daily fantasy continues to thrive.

The reason why, Melone explains, comes down to the industry's successful contention that the millions of of players who engage in daily fantasy are not participating in a game of chance, as government officials have argued, but rather one of "skill." It's an argument that has thus far held up to legal scrutiny, thanks in large part to a 2006 law called the Unlawful Internet Gambling Enforcement Act.

That law, passed in large part to stop credit card companies from funding offshore online gambling, included a specific exemption for certain forms of wagering—fantasy sports included. Specifically, the law gave its blessing to any activity that had "an outcome that reflects the relative knowledge of the participants."

The federal exemption for fantasy sports does not affect state laws that define gambling but it buttressed the industry's argument that its games are not gambling activities. Indeed, the Fantasy Sports Trade Association (FSTA) uses the law as justification for its stated claim that fantasy sports are at their core "games of skill."

Government officials, meanwhile, continue to make their counter-argument. Putting the merits of those claims aside, however, Melone says he believes both sides would be better served to move beyond that debate. Doing so would not only benefit the industry, but society as a whole.

"We need to stop hiding behind this false dichotomy of skill vs. chance," Melone says. "We should admit what this actually is, and regulate it appropriately." The key characteristic of gambling activities is risk-creation. Fantasy sports shares this characteristic.

What daily fantasy is, Melone says, is gambling—and it's easy enough to explain why: specifically, he says, it's "almost impossible" to find any activity that is entirely skill based. "For example, take calculus," Melone says. "How a student does on any given exam is predominantly skill-based, yes, but there's also an element of chance. Were you sick the night before the test? Did something happen to your family? All of these random events that you don't control can and do have an impact on performance.

"However, it is beyond dispute that calculus is a predominately skill-based activity. Does this mean a math professor can run an operation whereby calculus students wager against each other with respect to their grades and the professor takes the "house" cut? Of course not."

Moving forward, then, Melone believes a common sense regulatory approach should be adopted. Rather than continuing the chance vs. skill debate, Melone believes both the industry and government should recognize that daily fantasy, just like casino gambling and sports wagering, is a form of gambling regardless of whether success depends predominantly on skill or chance. And then, just as with those activities, daily fantasy should be regulated in a way that the states see fit.

"[Fantasy sports] are fun and people like playing these games—and there's nothing wrong with that," he says. "We do this with other things all the time. Why do we allow casinos? Obviously, we do so for revenue and budget reasons but also because they are fun for people. There are a lot of things in our society that may have some negative impacts but that we allow because we believe those negative effects are outweighed by the pleasure people take from it. So let's call it what it is, and stop hiding behind the niceties." ●

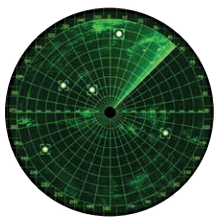
> "WE NEED TO STOP HIDING BEHIND THIS FALSE DICHOTOMY OF SKILL VS. CHANCE. WE SHOULD ADMIT WHAT THIS ACTUALLY IS, AND REGULATE IT APPROPRIATELY."

Matthew Melone has written extensively about comparative forms of doing business, executive compensation, partnership taxation, accounting standards and corporate political activity. He received his Masters of Taxation from the Villanova University School of Law and his J.D. from the University of Pennsylvania.

ELECTRICAL & COMPUTER ENGINEERING

THE RENAISSANCE OF PASSIVE RADAR

Rick Blum uses advanced signal processing techniques to produce models for radar that can be tools for the design of real-world products.



Active and passive radar will begin working their way into devices on the Internet of Things, says Blum.

Written by **Bob Fisher**

Illustration by **Santtu Mustonen**

What do you envision when you think of radar? Massive, rotating antennas at airports tracking your last flight? Colorful precipitation maps presented by your local TV meteorologist? Beams sweeping the sky in search of incoming missiles?

Get used to experiencing radar much closer to home, says Rick S. Blum, the Robert W. Wieseman Professor of Electrical and Computer Engineering. Thanks to a concept known as multiple input multiple output (MIMO) radar, which Blum is credited with inventing with a team of academics and Bell Labs collaborators, sensors are getting better at identifying smaller objects at close range—perhaps that pedestrian crossing the street in front of you, or the burglar entering your side window.

"I'd like to see radar work its way into commercial devices, and this seems to be happening, maybe first with automobiles," says Blum. He currently has National Science Foundation funding to do the math to quantify the feasibility of passive radar, which uses advanced signal processing techniques to measure reflections from objects illuminated by ambient radio signals in the environment—cellular phone transmissions, AM, FM, and TV broadcasts, for example.

The idea of passive radar is nearly as old as radar itself. Before and during World War II, the British deployed transmitters and receivers to create an active radar net around the south of England, which could detect Nazi aircraft forming over France. For their part, the Germans figured out how to detect RAF fighters over the North Sea by measuring beams from the British transmitters reflecting off of them.

With conventional active radar, a central transmitter sends high power pulses of radio waves in many directions. If a target, such as an aircraft, is in range, the signal will bounce back to the originating antenna (the detection part of radar). The time it takes to receive this return signal indicates how far away the object is, and the Doppler effect uses small shifts in that signal's frequency to determine whether the target is moving away or towards the radar station.

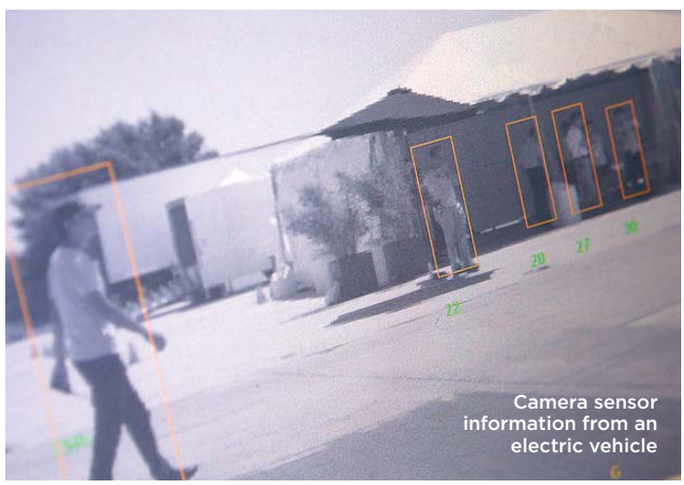
MIMO radar is derived from the principles of MIMO communications techniques that give you faster Wi-Fi with multiple antennas and allow stronger cellular coverage. Blum worked with researchers at Bell Labs who made the surprising discovery that adding transmit and receive antennas "significantly increased the rate that data could be passed," he says. "Nobody expected that." (Interesting fact: The Bell team pronounced the term "mee-moh," while later researchers adopted the rendering "my-moh," Blum says. No-one knows why, although a New Jersey/New York accent may be involved.)

Having multiple antennas creates "apparent" bandwidth, which can be thought of as a larger hose to move data. Your home router with a four-antenna array downloads your Netflix much faster than any one channel could alone (provided your device's antennas are similarly configured). Blum determined that the technique was applicable to radar, too.

"The idea is simple: If you want to understand a situation better you look at it from different points of view," he says. "Radars located far apart provide quite different views of an object. Combining these streams of data gives more reliable object detection." The technique also makes it easier to identify and reject spurious emissions and clutter in the signals.

Because radar returns are highly dependent on the angle and direction at which they hit the target, "moving an antenna a tiny bit can take you from a very strong signal to none at all," Blum says. "With many antennas it is highly likely some of the antenna returns will be large, providing more reliable target detection due to the inherent diversity." Properly deployed, separated antennas "can also obtain very high resolution on the location of the target or an image you can use to classify whether it is a person or an airplane."

Their highly cited work on MIMO radar led many to credit Blum's team with



Camera sensor information from an electric vehicle

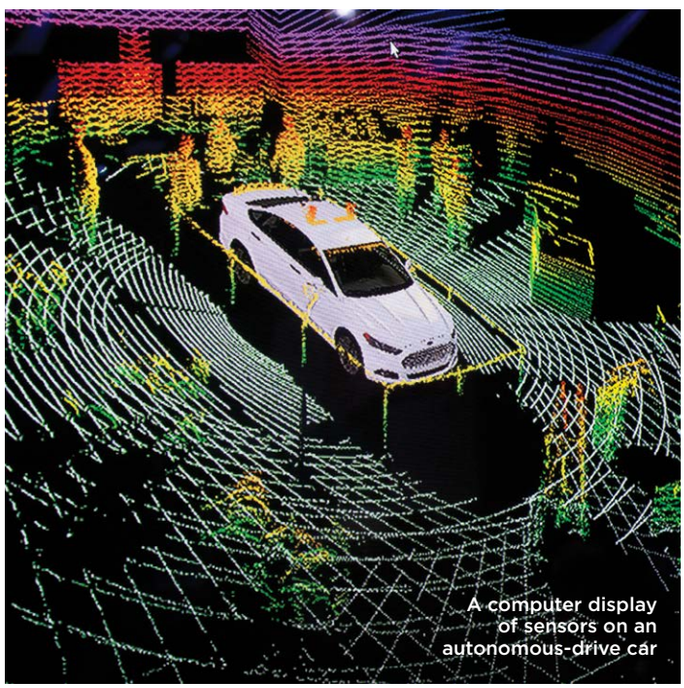
Rick S. Blum is the director of Lehigh's Integrated Networks for Electricity Cluster and the Signal Processing and Communication Research Lab. Blum is a Fellow of the IEEE, an IEEE distinguished lecturer, and an IEEE Third Millennium Medal winner. He received his Ph.D. from the University of Pennsylvania.

inventing the concept. A series of three articles introducing MIMO radar have been cited nearly 4,000 times. A 2016 analysis by the Canadian government found that Blum is in the top 1 percent of researchers cited in the radar field.

PASSIVE RADAR RETURNS

Why, after many tests and abandoned systems over the years, is passive radar experiencing a renaissance of interest?

"Passive technologies are underdeveloped," Blum concedes, but offer many advantages. Unlike the early days, most parts of the world are rich in digital communications signals that can potentially serve as radar illuminators. And as competition for cluttered radio spectrum increases, it makes sense to find out if signals can have dual use. In tactical situations, military units can detect nearby targets without broadcasting a signal that would allow enemies to locate them.



A computer display of sensors on an autonomous-drive car

"Not to mention, it's a heck of a lot easier and cheaper if you don't have to produce and power your own transmitter," he says.

Blum's work focuses on the mathematical simulation of systems, producing models that can be tools for engineers designing real-world products. The work involves advanced signal processing techniques.

With active radar, the recipient knows everything about the signal being transmitted — its origin, power, frequency, what data is carried on it. So it is relatively straightforward to isolate returns from the target.

A passive system using, for example, a cellular tower, suffers a number of "losses" — uncertainties that reduce the accuracy of the result. But the losses are not insurmountable, based on Blum's research.

"If I know I am looking at a GSM or LTE (cellular) signal, I know the form of the wave, and the frequency. I don't know what bits are being transmitted because of the conversation on the channel, but I can estimate them," he says. "It turns out that the losses are pretty small, and passive works almost as well as active."

Blum and collaborators have already published a number of results under the NSF grant. He has shown the potential improvements that come from increasing the number of transmit and receive antennas in situations with high signal-to-noise ratios, and is working to refine the calculations to measure performance even with weak signals.

"We've developed a really intricate model" with statistical descriptions for reflection and clutter as well as correlation of signals, Blum says. This model is helping to derive an optimal performance measure for passive systems based on the number of transmit and receive antennas.

A number of automobile manufacturers have reached out to talk to Blum about vehicle radars. Today active radar and cameras provide some basic driver-assist features, like helping to parallel park or proactive braking, but the push is on to release self-driving cars. Carmakers are interested in combining cameras and radar in self-driving systems because radar can "see" in inclement weather conditions where cameras are impeded. These systems are improving rapidly but are far from perfect. Last year, a Tesla driving on autopilot was involved in a fatal crash when its visual/radar system did not identify a tractor-trailer crossing a Florida highway.

> "I'D LIKE TO SEE RADAR WORK ITS WAY INTO COMMERCIAL DEVICES, AND THIS SEEMS TO BE HAPPENING, MAYBE FIRST WITH AUTOMOBILES."

Blum believes his simulations model interference and other poor signal conditions that could limit the use of passive radar in cars. But that doesn't mean the technology will show up in your vehicle anytime soon. Passive radar receivers have to find, identify and test potential signals before they can use them, and this work has to be automated in order for radar to just work without user intervention, he says.

Still, as growing use turns expensive radar modules into cheap chips, Blum thinks that active and passive radar will start working their way into home security sensors and other devices on the Internet of Things.

"This is why I love being an engineer," Blum says. "We don't just study math and physics. We exploit them to create things that add value to people's lives."

SOCIOLOGY & ANTHROPOLOGY

EXPRESSING DEPRESSION

Sirry Alang explores discrepancies between the standard approach to diagnosing depression and how African Americans perceive the illness.

"Ways of expressing depression... depend on the context including the nature of stressors, beliefs about depression, and might also be indicative of responses to stress," writes Alang.

Written by
Lauren Stralo

Illustration by
Edel Rodriguez

In diagnosing mental disorders, mental health professionals turn to the Diagnostic and Statistical Manual of Mental Disorders (DSM-V), which catalogues all American Psychiatric Association-recognized mental disorders and their symptoms. The manual is the primary source of diagnostic information not only for clinicians and researchers but also for psychiatric drug regulation agencies, health insurance companies, pharmaceutical companies, the legal system and policy makers.

This approach, however, may not be effective for African Americans suffering from depression, says Sirry Alang.

Depression in African Americans is expressed in ways that are inconsistent with symptoms of depression laid out in the DSM-V, says Alang, assistant professor of sociology and anthropology. She suggests that clinicians and researchers should be asking if the instruments they use to diagnose and assess depression—including DSM-V—are valid among African Americans.

Alang spent 12 months in a disadvantaged, predominantly black, urban neighborhood in the Midwest to understand how African Americans perceive depression. She participated in activities, shadowed residents and conducted informal interviews with key contacts in their homes, at church, during community events and in other public places. She details her findings in a paper, "'Black folk don't get no severe depression': Meanings and expressions of depression in a predominantly black urban neighborhood in Midwestern United States," which was published in the journal *Social Science & Medicine*. The study results have significant implications for the clinical assessment of depression and for the measurement of depression in community surveys.

In the paper, Alang suggests that African Americans perceive depression as a weakness inconsistent with notions of strength in the community, rather than as a health condition. Consequently, she says, "it is impossible to effectively diagnose and treat depression among African Americans if their perspectives about depression are not taken into account."

Although depression was expressed through classic depressive symptoms such as feeling hopeless, loss of sleep and losing interest in activities, Alang says, symptoms such as anger, agitation and the frantic need for human interaction were considered to be indicative of depression as well. These symptoms are inconsistent with symptoms of depression in the diagnostic manual.

If they are focused on depression as defined by the diagnostic manual, clinicians might "miss" symptoms such as anger in African Americans, says Alang. But clinicians won't miss these symptoms altogether if they are open to the possibility that some African Americans have their own beliefs about depression, and that they express symptoms consistent with those beliefs but inconsistent with how the DSM-V classifies depression.

Alang found that despite disproportionate exposure to social and economic disadvantage, the African Americans she studied perceive themselves to be resilient. Depression does not exist in a vacuum, but is linked to racial discrimination that is insidious and persistent within the context in which African Americans live, she says.

Alang concludes that improving black mental health calls for meaningful engagement in analyzing the racial effects of policies, practices and programs.

Sirry Alang's research focuses on the social determinants of health and mental health, and health inequities. Her work is grounded in sociological literature but cuts across several disciplines including community health, demography, health policy, anthropology and psychology. Alang received her Ph.D. from the University of Minnesota.

INTERNATIONAL RELATIONS

PROMOTING PEACE

Successful peacemaking between longstanding adversaries, argues Norrin Ripsman, is almost always imposed by states from the top down and then sustained by societies.

Ripsman spent more than a decade working on ***Peacemaking from Above.*** During this time, he coauthored three other books, coedited four and served on the faculty of Concordia University in Montreal.

Written by **Kurt Pfitzer**

Illustrations by **Emmanuel Polanco**

Those who doubt that peace can ever be achieved between deadlocked adversaries such as Israel and the Palestinians, says Norrin Ripsman, might find hope in the example set by France and Germany.

Between 1870 and 1945, says Ripsman, the Monroe J. Rathbone Professor of International Relations, the two European neighbors fought three bitter wars—the Franco-Prussian War of 1870-71, World War I (1914-18) and World War II (1939-45).

"The death and destruction caused by the wars involving Israel in the Middle East," says Ripsman, "pale in comparison to the death and destruction caused by the three Franco-German wars. And the hatred that the French once held toward the Germans is almost impossible for us to imagine today."

In annual surveys conducted by the French Institute of Public Opinion, says Ripsman, the French until the early 1960s ranked Germany near the bottom when asked to list their country's friends among the other nations of Europe. By the early 1970s, the surveys found, West Germany had become France's best friend in Europe; by 1980, it was France's best friend in the world.

In 1989, when East and West Germany were reunified, 80 percent of Frenchmen said they would not fear German rearmament if it were done in the context of European institutions and democracy.

Ripsman explores the causes of this turnaround in a chapter in his latest book, *Peacemaking from Above, Peace from Below: Ending Conflict Between Regional Rivals*, which was published last year by Cornell University Press. The book also devotes separate chapters to the Egyptian-Israeli peace treaties of 1978-79 and the Israeli-Jordanian Treaty of 1994. A fourth chapter examines other examples of peacemaking efforts. Each study involves a neighboring pair of nations of comparable power.

In writing *Peacemaking from Above*, Ripsman conducted personal interviews, did archival research and consulted secondary sources of peace treaties. He concludes that successful peacemaking is almost always imposed by governments and stabilized by societies. Governments, he says, often disregard societal objections. Their motivations include concerns over a third state that poses a greater threat to security than the adversary, pressure from a powerful outside actor, and economic troubles that threaten their hold on power.

In contrast, peace is sustained by societal groups through cultural and economic exchanges, trade, and mutual cooperation in international institutions. The prospects for long-lasting peace, Ripsman says, improve if adversary states begin to democratize, if dispersed ethnic groups are reunited, and if stateless minorities gain self-determination.

His findings, he says, have practical as well as theoretical significance. Western nations and international organizations, he believes, squander money, time and energy by investing in bottom-up peacemaking efforts between adversaries before their governments have agreed to make peace. For example, the U.S., the European Union (EU) and Japan all support exchange programs involving Israeli and Palestinian children, and Pakistani and Indian children, although their nations' governments have not yet agreed to make peace.

"We waste a lot of resources putting the cart before the horse by spending on bottom-up strategies," Ripsman says. "We need to promote peace properly and stabilize it properly. We need to achieve agreement by giving incentives to rival states or by putting pressure on these states and using a carrot and stick when appropriate."

Peacemaking from Above grew out of an article Ripsman wrote on Franco-German peacemaking after World War II, which was published in 2005 by the *International Studies Quarterly*.

"I began to wonder if the lessons from France and Germany could be generalized beyond Western Europe, which is a large and homogeneous region from the standpoints of culture, institutions and religion. Could these lessons be portable to the Middle East or South Asia, which are tremendously different? Or did the Franco-German example explain just one case?"

Norrin Ripsman has held fellowships at the Hebrew University of Jerusalem, the Kennedy School at Harvard University and the Norwegian Nobel Institute. His research interests also include democracy and national security and the impact of globalization on national security. Ripsman received his Ph.D. from the University of Pennsylvania.

The peace agreement between Egypt and Israel, says Ripsman, remains precarious because it depends on the whims of the nations' governments.

A second motivation for writing the book was Ripsman's conviction that the prevailing theories of peacemaking—liberal, realist and constructivist—did not fully explain it.

"One reason I decided to write my second book was that I was not satisfied with existing theoretical tools. Realists believe states make peace over the objection of their societies. Constructivists say peace occurs because societal attitudes change and compel leaders to change. They believe international institutions play a role.

"Liberals say peace occurs because of societal factors. They believe societies are more rational, and that if you change incentives, people will change their behavior. If people see they can gain economically by achieving peace, or that they stand to lose otherwise, they will calculate the costs of continuing a conflict and opt for peace."

Each of these theories explains part of the success of Franco-German peacemaking, Ripsman says. After World War II, French leaders faced an unchanging reality: the victorious, expansionist Soviet Union posed a greater threat to French security than did devastated and defeated Germany. Also, the United States was pressuring France to make peace, and France's leaders realized the need to stabilize the fragile French Fourth Republic. These factors helped motivate French leaders in 1954 to sign a peace treaty with West Germany and agree to its rearmament under NATO supervision.

"Statist factors, including a common Soviet threat, U.S. economic and military incentives, and regime-survival and state-building motives, brought about Franco-German cooperation and peace," Ripsman writes in *Peacemaking from Above*. "There is no evidence [that] public pressures, significant pressure from business interests, or a common identity created by participation in powerful regional institutions compelled peacemaking."

But if peace was imposed from the top, Ripsman writes, it was stabilized and socialized "with liberal and constructivist mechanisms. In particular, the entrenchment of German democracy within a network of economic interdependence...helped abate societal antagonism and build a foundation for a stable peace."

"Since the signing of the treaty," he says, "relations between France and Germany have been characterized by a high degree of interdependence, trade and cultural exchanges. The two nations belong to a variety of institutions, which are well-established, such as the European Economic Community—now the EU, and the Council of Europe, not to mention NATO. Both states are now democracies and the region they occupy is a zone of democratic peace."

In sharp contrast to France and Germany, says Ripsman, Egypt and Israel have failed to build a stable peace since signing the Camp David Accords (1978) and the Egypt-Israel Peace Treaty (1979), which were facilitated by the U.S.

The two nations had geopolitical reasons for initiating a rapprochement—Egypt desired the return of the Sinai Peninsula that Israel had conquered and occupied since the Six-Day War of 1967, while Israel hoped to pacify the most powerful of the Arab states with which it had fought several wars since achieving its independence in 1948. And U.S. President Jimmy Carter had coaxed the two former adversaries to make peace with offers of military and economic assistance.

But, says Ripsman, while Egyptian President Anwar Sadat and Israeli Prime Minister Menachem Begin made peace over the objections (especially in the case of Egypt) of their respective populations, their nations failed to stabilize the peace with liberal and constructivist approaches.

"Israel and Egypt have achieved an enduring settlement," says Ripsman, "but you cannot call this a stable settlement. There has been no war or repudiation of the treaty since Camp David in 1978. But there have been frequent crises and attempts to revise the treaty, and there has been no societal buy-in, no significant effort to bring society on board through democratization or economic exchanges."

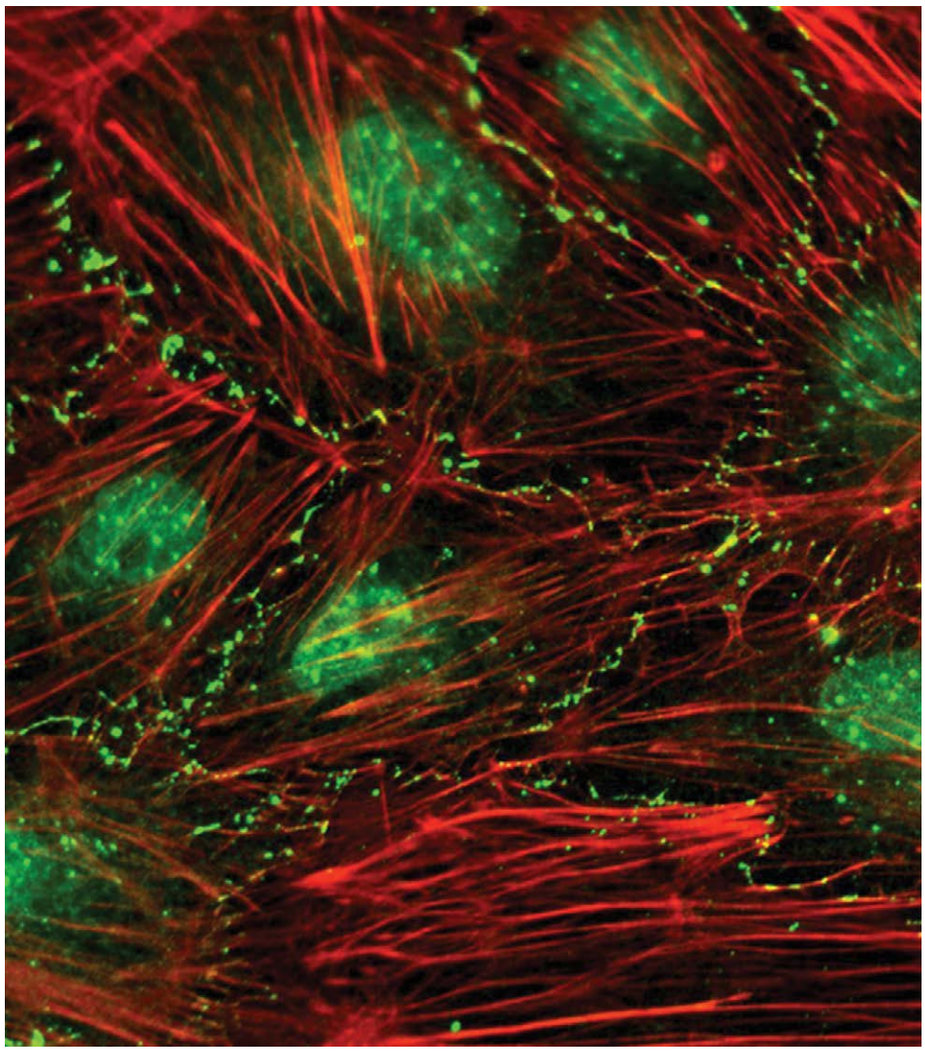
"WE WASTE A LOT OF RESOURCES PUTTING THE CART BEFORE THE HORSE BY SPENDING ON BOTTOM-UP STRATEGIES. WE NEED TO PROMOTE PEACE PROPERLY AND STABILIZE IT PROPERLY."

When Egypt and Israel signed the Camp David Accords, says Ripsman, they also ratified 65 economic, social and cultural protocols. None of these has been implemented, however, since the assassination of Sadat in 1982. Nor do the two nations cooperate in any significant international institutions. And although Israel returned the Sinai Peninsula to Egypt, it has failed to resolve the state-to-nation issue with the Palestinians.

As a result, Ripsman writes in *Peacemaking from Above*, the peace agreement between Israel and Egypt remains precarious, dependent on the whims of the nations' governments, especially Egypt's.

"If the Egyptian military were to relinquish power, to the extent that Egypt undergoes a democratization process, the possibility exists that a government hostile to the treaty could rise to power and no longer view peace as consistent with Egypt's state interests."

"Had serious attempts been made by outside actors such as the U.S. and by the Egyptian and Israeli governments to bring the rival societies on board after the peace treaties were signed," he says, "we would see a greater chance for an enduring treaty."



Falk studies the degradation phase of the gap junction life cycle.

Written by **Lori Friedman**

Image courtesy of **Matthias Falk**

BIOLOGY

CELLULAR COMMUNICATION

Matthias Falk is mapping the life cycle of cellular gap junctions to unlock the mystery of mutations that cause disease.

Few have a better understanding of the life cycle of a gap junction than Matthias Falk and his team. Falk has spent the last 14 years studying the internal machinery of the final stage of the life of gap junctions—the channels through which cell-to-cell communication occurs.

Ultimately, his goal is to gain a deep understanding of how gap junctions function, to better understand what happens when they malfunction.

"We need to understand what's normal before we can know what is not normal," says Falk, professor of biological sciences.

Gap junctions are special. They are the only known cellular structures that allow a direct transfer of signaling molecules from one cell to another by forming hydrophilic (water filled) channels that bridge the plasma membranes of neighboring cells. One cell provides half of the channel, a neighboring cell provides the other half. The halves connect to form one channel that allows the two cells to send signals directly into each other's cytoplasm.

Proteins called connexins form the building blocks of gap junctions. A number of diseases are associated with connexin mutations, including diseases of the heart, cataracts, hearing loss, neuropathies, skin and bone disorders, and cancer. However, there is little understanding of how these gap junctions are assembled, maintained and then degraded—much less how these processes could go awry.

"My lab has focused on the degradation phase of the gap junction life cycle—after the cell has built and then maintained the structure—because impaired removal of the channels is linked to disease," says Falk.

Falk and his team are able to observe and characterize a gap junction's life cycle in living cells through immunofluorescent microscopy using a process called transfection. They fuse the DNA of a green fluorescent protein to tag the connexin protein of interest and then push it through a cell membrane—in much the same way a virus infects a healthy cell. When lit, the tag enables them to observe the proteins.

"We can follow, in real-time, the degradation process, watching how the old structure is internalized into the cell, becomes a vesicle within the cell's cytoplasm and moves away from the plasma membrane," says Falk. "This is how we have been able to obtain an understanding of the complex internal machinery driving the gap junction internalization process on the molecular level."

Characterizing these complex cellular processes is key to developing treatments for disease.

"Before a drug can address a mutation in the gap junction that is causing something to go wrong, we need to find out what it looks like when it goes right," adds Falk.

Falk's work could be classified under what the National Institutes of Health have dubbed Bench-to-Bedside science. This refers to research that translates basic scientific findings into therapeutic interventions for patients and increases understanding of important disease processes.

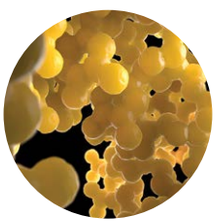
Through their study of gap junctions, Falk and his team hope to exemplify the bench that may one day make treatment a reality at a patient's bedside.

Matthias Falk received his Ph.D. from the University of Heidelberg, Germany. He was trained as a cell biologist and is interested in the processes related to protein biosynthesis, intracellular trafficking, the assembly of multi-protein complexes, and how cells in multi-cellular organisms communicate with each other. Before coming to Lehigh, Falk worked at The Scripps Research Institute (TSRI) in La Jolla, California.

NEUROSCIENCE

A GENETIC BRAKE

Julie Miwa seeks to understand the role of the lynx *gene in learning and behavioral adaptation.*



Miwa discovered the *lynx1* gene as a graduate student at Rockefeller University.

Written by **Kelly Hochbein**

Young children absorb new information like sponges, says Julie Miwa. Language learning, for example, is easier for children than adults, who tend to require more training and practice. Neuroscientists call this young, robust period of learning in children "the period of plasticity."

"[The period of plasticity is] this window where not only do we learn a lot of information, but actually the connections in our brains are shaped and refined," explains Miwa, assistant professor of neuroscience. "So new connections are made, other connections are taken away, and that's to make the brain have a more accurate understanding of the external world that the individual experiences."

Unfortunately, like all good things, that period of plasticity usually comes to an end. This happens, says Miwa, thanks to the *lynx1* gene.

Miwa discovered the gene as a graduate student at Rockefeller University, and she describes it as a "brake" on the critical period of plasticity. *Lynx1* turns on at the end of the period of plasticity. Once that brake is applied, learning requires more work.

Miwa discovered that the removal or "knockout" of *lynx1* through genetic engineering can extend the period of plasticity into adulthood. One element of her research focuses on how scientists might control the gene. Her animal studies have yielded compelling results.

Knocking out the *lynx1* gene in mice results in better associative learning, says Miwa. These so-called "knockout mice" demonstrate an increased ability to make connections. Miwa believes that, similarly, humans with a mutation of the gene might retain the period of plasticity as adults.

"Maybe they're better able to make associations, maybe they're more open to new information because they can mold their synapses and wiring with more ease," she says.

To learn more about the *lynx1* mutation in humans, Miwa and her team, aided by Almut Hupbach, professor of psychology, administer psychological tests to see how well human study participants learn, how open they are to new information and how creative they are. The team also extracts DNA from a saliva sample from each participant to determine if any participants have the *lynx1* mutation. They then attempt to correlate mutations with advanced cognitive abilities. A portion of this research was conducted over the past two summers as part of Lehigh's Mountaintop program, a unique learning environment which allows students and faculty mentors the freedom to explore open-ended questions.

A better understanding of how to turn the *lynx1* gene off might be particularly helpful in instances of stroke or Alzheimer's disease, says Miwa. If, for example, a stroke patient has suffered damage to the part of the brain that controls speech, a return to the period of plasticity might improve their ability to regain language. Likewise, Alzheimer's patients might see improvement in memory function.

EMOTIONAL REGULATION

Just as *lynx1* suppresses learning, another gene, *lynx2*, suppresses fear and anxiety. *Lynx2* is expressed in the amygdala, the part of the brain that controls emotion. Miwa explores the role of *lynx2* in emotional regulation and resilience to determine how humans adapt to a world in constant flux.

Lynx2 knockout mice demonstrate higher anxiety levels and are less willing to interact with other mice. In humans, Miwa says, a *lynx2* mutation might affect not only an individual's anxiety level, but also the ability to socialize, impacting resilience and overall success.

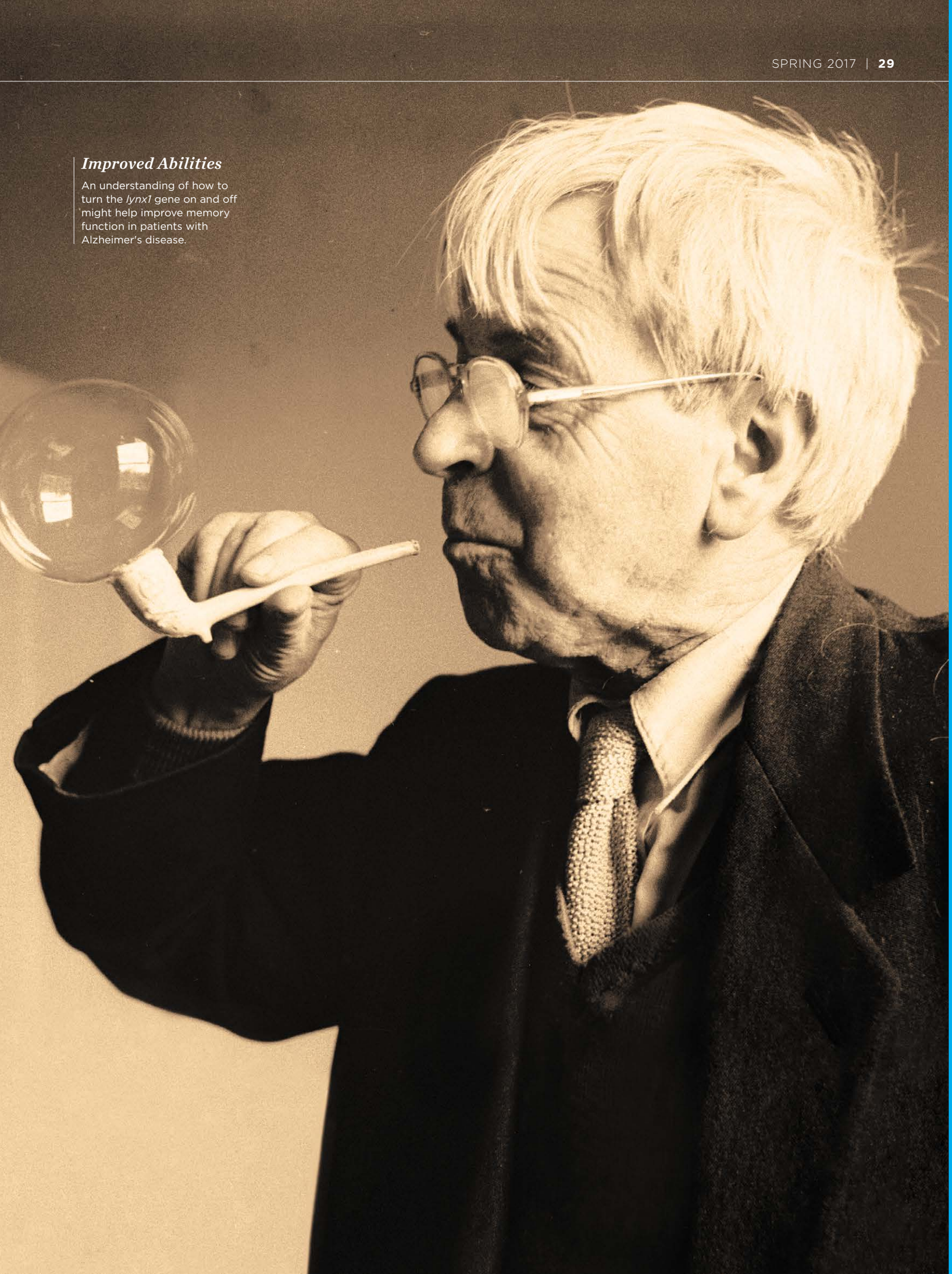
"[A *lynx2* mutation] can have a lot of negative effects on a person's ability to navigate the world," says Miwa. "I think it could have really substantial effects on an individual's success, their sense of well being, how they go through the world. I would like to move the project into areas like longitudinal studies [and go] out in the world to see how it affects people and their resilience over time."

The learning and behavior dimension of this *lynx* gene research is an extension of Miwa's regular research, which focuses on complex neurobiological processes in genetic mouse models and how they are regulated through the cholinergic system. The cholinergic system is a modulatory neurotransmitter system, which means it releases or responds to the neurotransmitter acetylcholine, and *lynx* genes are regulatory proteins over the specialized proteins acetylcholine binds to, nicotinic receptors of the cholinergic system. Moving beyond synaptic connections and genes, Miwa's outward-leaning, psychology-based approach to *lynx* might reveal much about human learning and behavior.

"THE WORLD IS CHANGING ALL THE TIME, SO IT BEHOOVES US TO BE CONSTANTLY ADAPTING."

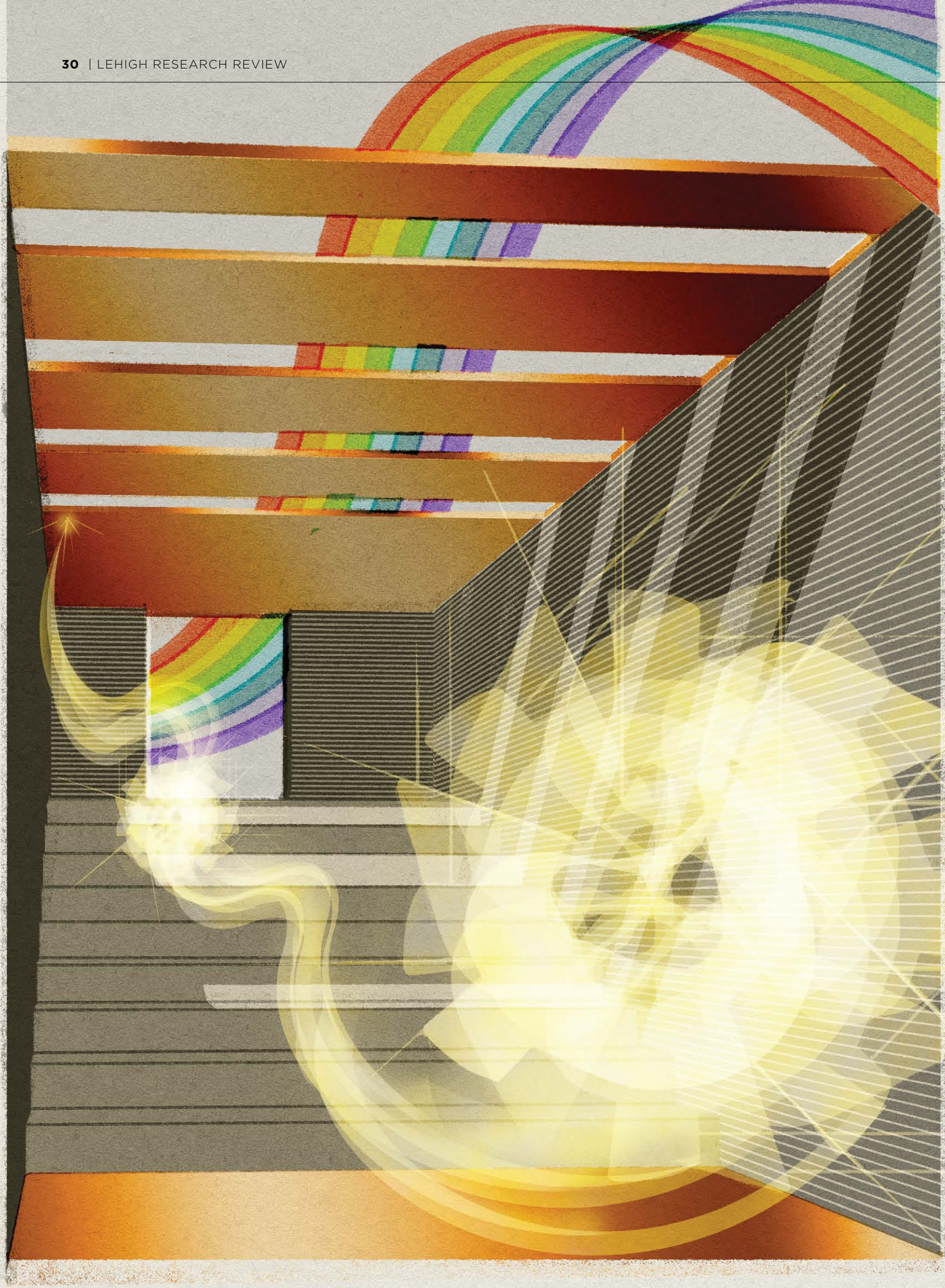
"The world is changing all the time, so it behooves us to be constantly adapting," she says. "[That] might be hard because we're outside the critical period [of plasticity]. So you can imagine then, if you can understand about turning on and off the gene, that we'd be better able to adapt to these new challenges." ●

Julie Miwa's research focuses on the genetics of learning and behavioral plasticity in the brain. She earned her Ph.D. in neuroscience from The Rockefeller University and trained further in the psychology department at Yale University. She also served as a senior research fellow at the California Institute of Technology.



Improved Abilities

An understanding of how to turn the *lynx1* gene on and off might help improve memory function in patients with Alzheimer's disease.



ELECTRICAL & COMPUTER ENGINEERING

A SHARPER FOCUS FOR PLASMONIC LASERS

Sushil Kumar has conducted five years of experimental and theoretical research on plasmonic lasers. His work might lead to commercial applications for the tiniest of nanolasers.

A terahertz plasmonic laser cavity is enclosed between two metal films (with periodic slits on the top film). The colors represent coherent SPP light waves. One wave is confined inside the 10-micron-thick cavity. The other, with a large spatial extent, is located on top of the cavity.

Written by
Kurt Pfitzer

Illustration by
Leonie Bos

Lasers have become indispensable to modern life since they were invented more than fifty years ago. The ability to generate and amplify light waves into a coherent, monochromatic and well-focused beam has yielded applications too numerous to count: laser scanners, laser printers, laser surgery, laser-based data storage, ultrafast data communications via laser light, and the list goes on.

Lasers are found in all shapes, sizes and colors. They can be made of gases (gas lasers) or based on solid materials (solid-state lasers). They can emit light of different colors (or wavelengths or frequencies), from X-rays (short wavelengths) to visible to far-infrared (long wavelengths). They can be as big as a building (free-electron lasers) or as small as a laser pointer (semiconductor diode lasers).

In the past decade, researchers have attempted to miniaturize photonic technologies for dense integration onto tiny semiconductor chips. To that end, researchers are seeking to develop even smaller nanolasers, of which plasmonic lasers are the tiniest.

The plasmonic laser, says Sushil Kumar, associate professor of electrical and computer engineering, uses metal films or nanoparticles to confine light energy inside the cavity from which laser light is generated. By storing light energy inside the cavity through a combination of electron oscillations in the integrated metal films or nanoparticles, plasmonic lasers utilize surface-plasmon-polaritons (SPPs) to store energy in dimensions that can be made smaller than the wavelength of light that they generate.

This unique ability of plasmonic lasers makes them attractive for potential applications in integrated (on-chip) optics, for transporting large swathes of data on-chip and between neighboring chips, and for ultrafast digital information processing.

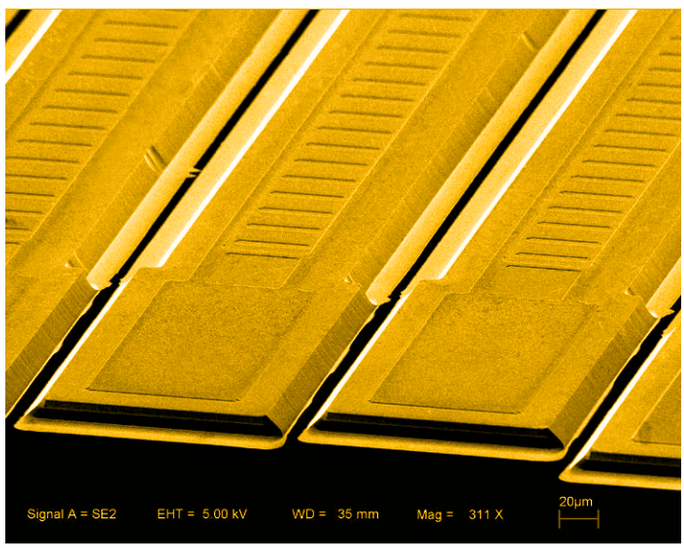
Several problems need to be solved, however, before plasmonic lasers can be widely used. One of the main issues, says Kumar, is the difficulty of extracting light from the cavity of a plasmonic laser. The lasers are also extremely poor emitters of light, and whatever light does come out is highly divergent rather than focused, which severely limits their usefulness.

While most plasmonic lasers emit visible or near-infrared radiation, Kumar's group develops plasmonic lasers that emit long-wavelength terahertz radiation, which are also known as terahertz quantum-cascade lasers, or QCLs. As the brightest solid-state sources of terahertz radiation, says Kumar, QCLs are uniquely poised to find applications in biology and medicine for sensing and spectroscopy of molecular species, in security screening for remote detection of packaged explosives and other illicit materials, and in astrophysics and atmospheric science.

Terahertz QCLs, however, also emit highly divergent beams, which poses an obstacle to commercialization.

Kumar and his group have demonstrated that it is possible to induce plasmonic lasers to emit a narrow beam of light by adapting a technique called distributed feedback. They have experimentally implemented a scheme for terahertz plasmonic lasers that emit radiation at extremely long wavelengths (approximately 100 microns). The light energy in their laser is confined inside a cavity sandwiched between two metallic plates separated by a distance of 10 microns. Using a box-shaped cavity measuring 10 microns by 100 microns by 1,400 microns (1.4 millimeters), the group produced a terahertz laser with a beam divergence angle of just 4 degrees by 4 degrees, the narrowest divergence yet achieved for such terahertz lasers.

Kumar, who has conducted five years of experimental and theoretical research on the project, described the results in an article published in *Optica*, the journal of



Sushil Kumar pursues research in far-infrared (terahertz) and mid-infrared photonics with quantum-cascade lasers and detectors and nanostructured intersubband semiconductor devices. He completed his Ph.D. research and postdoctoral training at the Massachusetts Institute of Technology.

the Optical Society of America. "Terahertz plasmonic laser radiating in an ultra-narrow beam" was written by Chongzhao Wu, a Ph.D. candidate in electrical engineering, and coauthored with Sudeep Khanal, also a Ph.D. candidate in electrical engineering, and John L. Reno of the Center of Integrated Nanotechnologies at Sandia National Laboratories in New Mexico.

DISTRIBUTED FEEDBACK THROUGH PERIODIC GRATINGS

Distributed feedback (DFB) in lasers was introduced in the early 1970s, says Kumar, when scientists learned that implementing periodicity (a patterned structure) enabled lasers to emit light at just one wavelength. The periodicity in the laser cavity provides feedback for sustained laser oscillations in the cavity by the mechanism of Bragg diffraction.

"There are two main reasons for giving lasers a periodic structure," says Kumar. "The first is to improve spectral selectivity. A laser can emit light in several closely spaced wavelengths, or colors. But a laser with a periodic structure can be forced to emit light at just one wavelength by the mechanism of spectral filtering. Such a spectrally pure, single-mode laser is often indispensable for many applications.

"A periodic structure can also enhance the quality of the laser beam by channeling light intensely into a tight spot. Such narrow beam lasers can deliver light energy to a location where it is needed most. They can shine for long distances, and are easier to manipulate and re-direct at a desired location using small optical components."

Many DFB schemes have been developed for different types of lasers. Because plasmonic lasers are relatively new, research to improve them using periodic photonic structures is still in its early stages.

Kumar describes his DFB scheme in the terminology of a microwave engineering principle called the phased-array antenna. These antennas are used to achieve high directivity (narrow beam) in radar and satellite communications. Phased arrays are also implemented in "microstrip transmission lines" that channel microwave signals onto printed circuit boards using metal films.

"Our technique allows a plasmonic laser to radiate in a narrow beam, very much like a phased-array antenna," says Kumar. His group implemented DFB in the laser by making periodic slits or "gratings" in one of the metal claddings that encase the laser cavity. The laser's unique ability to emit a monochromatic, focused light beam stems from the degree of periodicity.

"The period we choose depends on the desired wavelength of light from the laser, the refractive index of the cavity medium, and the refractive index of the surrounding medium," says Kumar.

The group's DFB technique has two unique aspects. The chosen periodicity is the most important technical contribution and, says Kumar, is distinctly different from previously established DFB design rules for solid-state lasers.

Second, the periodicity establishes an intense SPP wave which "hangs" in the surrounding medium of the laser's cavity while remaining tied to its metal cladding, and which propagates in tandem with another SPP wave inside the cavity.

"All plasmonic lasers have SPPs inside their cavities," says Kumar. "Our laser also generates SPPs in the air, or any other medium that may surround the laser. This is something unique which cannot be found in any other laser yet demonstrated.

"The large size of the SPP wave in the surrounding medium leads to a highly directive (narrow) radiation pattern from the plasmonic laser. This derives from the Fraunhofer diffraction formula in optics, which says the light-field distribution far from a light source (far-field) is the Fourier transform of the light-field distribution at the source (near-field). Effectively, when the near field is narrow, the far field is broad, and vice-versa.

"We have created a near field with a large spatial extent; this implies a narrow far-field or a focused beam."

Kumar and Wu have filed a patent application on their invention, which he says could help plasmonic lasers, especially terahertz QCLs with narrow beams, find commercial applications.

"There is a very strong interest in security spectrometry," the researchers wrote in an abstract for the recent TechConnect 2016 World Innovation Conference, where they won a TechConnect National Innovation Award. "Approximately 80 to 95 percent of explosives, and all commonly used ones, have unique and identifiable terahertz signatures."

"NARROW BEAM LASERS CAN DELIVER LIGHT ENERGY TO A LOCATION WHERE IT IS NEEDED MOST. THEY CAN SHINE FOR LONG DISTANCES, AND ARE EASIER TO MANIPULATE AND RE-DIRECT AT A DESIRED LOCATION USING SMALL OPTICAL COMPONENTS."

Kumar's group fabricates lasers in the cleanroom of Lehigh's Center for Photonics and Nanoelectronics. They grow their semiconductor material using molecular beam epitaxy through a collaboration with Reno. Kumar's project was supported by the National Science Foundation (NSF) from 2011-14. Kumar also received the NSF CAREER Award in 2014 to design the semiconductor material that constitutes the terahertz laser cavities. That material is based on alternating layers of gallium-arsenide and aluminum gallium-arsenide.

Kumar recently received another NSF award to improve output from terahertz plasmonic lasers so they emit up to 100 milliwatts of optical power while holding the angular divergence of the laser beam to less than 5 degrees. The group proposes to improve radiative efficiencies by "phase-locking" multiple laser cavities together, so they can operate in tandem and deliver brighter intensities of laser light at the desired location.

ART HISTORY

MAXIMUM IMPACT

Susan Kart studies contemporary West African art and seeks to reach those her research will impact the most—the people of West Africa.

Kart included the work of Zanele Muholi in her rewrite of the African arts chapters in the textbook *Art History*.

Written by
Kelly Hochbein

Moustapha Dimé, the Senegalese sculptor and subject of Susan Kart's doctoral dissertation and ongoing research, was driven by education and outreach. A leader in Senegalese contemporary art until his death in 1998, Dimé sought to reclaim sculpture as a modern art form for Senegalese artists as part of a new art movement in Senegal known as Récupération. Kart's approach to her study of Dimé reflects the artist's philosophy.

"His whole idea was not to be an artist for himself, for his own glory. Instead he felt he had been given this gift, and the social impact he could have with his art mattered more to Dimé than his own fame or fortune," says Kart, assistant professor of art history and Africana Studies.

Because she conducted her research about Dimé in his native Senegal, Kart decided her first single-author book on the artist belonged with the Senegalese people. A Senegalese publisher, Nouvelles Editions Africaines du Senegal (NEAS), will publish her book in French this year. It will be only the second French-language volume on Dimé in existence; the first is out of print.

"What matters to me is the quality of my work and the appropriateness of my work and the impact of my work. And this book will have a much greater impact in Senegal," Kart says. "It's a political act. In everything I do where Dimé's work is concerned, I sit there and think, 'Would Dimé have approved? Am I following the path that he was following?'"

This approach connects seamlessly with the National Endowment for the Humanities grant Lehigh's Africana Studies program received in 2015. The grant supports the outreach of intellectual material "so it doesn't just stay within the academy and is disseminated and made useful where it matters."

"I do not intend to travel to West Africa, do my research, come home, publish here and never bring that information back to where I did it," Kart explains of her work. She also hopes that publishing her work internationally will further engage Senegalese art historians and cultural thinkers who previously could not access her work and might provide additional perspective to it.

"Then we can start to have a dialogue about what I did not understand, what I got wrong, and what they think," she says. "That has been completely missing in most art historical work—publishing only in the U.S. denies us important dialogue between scholars in multiple places."

Even more broadly, Kart hopes to make information about African art more public at home as well as abroad. Kart recently rewrote the chapters on the arts of Africa for the sixth edition of the Stokstad/Cothren textbook, *Art History* (forthcoming 2017), published by Pearson. She chose to end the chapter with South African activist/artist Zanele Muholi, a self-identified lesbian photographer who documents the lives of lesbian, gay, bisexual, transgender and intersex communities in South Africa and abroad.

The opportunity to take on the African art chapters in *Art History*, she says, aligned perfectly with her goals: "This is a nationally used textbook in college and advanced high school courses. For any number of students, this is the only book of art they will ever read. It is the only material on African art to which they may ever be exposed. … Michael Cothren and the editors allowed me to really push the boundaries of what people expect from African art and to do it in a very public way." ●

Susan Kart specializes in the arts of Francophone West and Central Africa from the colonial period to the present. Her research in Africa takes place primarily in Senegal. Kart obtained her graduate and doctoral degrees from Columbia University.

SOCIAL JUSTICE AND PUBLIC HEALTH

Julia Lechuga is working with community groups at the El Paso-Ciudad Juárez border to reduce risky behaviors among drug users and curtail the spread of infectious diseases.

"We think of violence in terms of the crime problem, and we consider having more police officers or arresting more people," says Lechuga. "We don't think of the public health aspects of this."

Written by **Mary Ellen Alu**

Photos by **Jarome Sessini**

The woman was a crack user, engaged in the sex trade and living on the streets of San Salvador. When Julia Lechuga and other public health advocates first met her, she was seeking respite at a soup kitchen in the troubled city, where violence and illicit drug use was rampant.

The woman decided to take an HIV test offered by Project Encuentro, a five-year international project that Lechuga was helping to develop and implement to reduce risky behaviors among drug users, and thus, help curtail the spread of infectious diseases in El Salvador's capital city.

"We first established trust," says Lechuga, in explaining how the woman, in her 30s, had come to take the test after meeting project leaders at the soup kitchen. "We were there every day."

Learning she was "negative," the woman then opted to take part in an intensive two-day program that Project Encuentro also offered so that she could learn how to further protect herself, such as how to negotiate condom use with a partner, and to fortify her self-worth.

"We also cover human rights," says Lechuga, assistant professor of education and health, medicine and society. "The intervention is trying to give humanity back to this person who lost it somewhere."

Eventually, the woman's sex work stopped. She found a place to live and began reconciling with her four children. When she came back a year later to thank the project leaders, she carried the "intervention" manual she had been given, which also contained her reflections on her situation.

"Her story was powerful," says Lechuga. "She came back and said, 'When I'm feeling down, when I need something, I open [the manual] up and start reflecting again on why this is important.'"

Project Encuentro's preliminary findings show the woman's story was not an anomaly. Participating high-risk drug users became better at protecting themselves against HIV—their attitudes toward condom use improved, and those with multiple sex partners increasingly used condoms during sex, Lechuga says. The mean number of days that participants reported consuming crack cocaine dropped.

Also, using social network methodologies, project leaders saw a boost in HIV testing rates in the three community sites involved in the project. In a 12-month peer-referral period, in which participants were asked to refer others with whom they had used drugs or engaged in sex, 582 community members received HIV testing. That compared to 265 community members who received testing during a 12-month self-referral period.

"Once somebody knows their HIV status, they're more likely to change their behavior, and we're able to link them into care," she says. "The sooner you are diagnosed, the sooner you can get on medications. Your level of infectiousness is going to be reduced.

"Research suggests it does help—the harm reduction approach, the idea that you will help individuals who have self-efficacy to, for example, protect themselves when there are situations of risk."

Given the gains in San Salvador, Lechuga felt the intervention could be adapted to target drug users living along the U.S.-Mexico border, where heroin use is prevalent, in an attempt to reduce the spread of infectious diseases there. Using the preliminary findings from her work in San Salvador, she successfully sought funding from the National Institutes of Health.

Ciudad Juárez, Mexico

Julia Lechuga's research consists of developing and testing health behavior change interventions for ethnic minority communities using community-based participatory research methods. She received her Ph.D. in health psychology from the University of Texas at El Paso.

Now in the first year of the five-year, $2.1 million study and outreach program, Lechuga is working with two community-based organizations—the Alliance of Border Collaboratives in El Paso, Texas, and Programa Compañeros in Ciudad Juárez, Mexico.

As in San Salvador, Project Encuentro will have three components: social network HIV testing for drug users, peer network intervention administered by trained peer leaders to small networks of drug users, and community events that will address topics perceived as important to reducing drug users' HIV risk.

The project aims to help the two organizations build their capacity to tackle the public health problem in the border communities.

"We are using a social network approach and these organizations are new to this approach," Lechuga says. "This is an approach that is evidence-based, and we are working to get them to implement these strategies, so that when the grant [money] is gone, the learning and the experience stays with them."

REDUCING STIGMAS

Lechuga was born and raised in a bilingual household in El Paso. She said her frustration in not knowing how to help family members who were substance abusers, as well as her deep love of her Latino community, led her to her research and advocacy. "It's very personal," she says.

She also recognizes the stigma around substance abuse and mental illness. "Trying to reduce that stigma as well is something that motivates me," she says.

The border cities of El Paso and Ciudad Juárez form a culturally distinct area of about 2.2 million people. Poverty is high. Each year, about 5 million people cross the bridges connecting the two cities, with many making their way, back-and-forth, to home and school and work.

"When you talk about illnesses and infectious diseases, this is really a place where the illness itself is crossing boundaries," she says.

There are attempts, too, to move drugs through the border crossing, the second busiest international point of entry into the United States. When those attempts fail, she says, a lot of the drugs wind up in the communities, leading to a high prevalence of substance abuse among mostly men, but also women.

"There's a lot of heroin use, and having access to clean syringes is a harm-reduction approach because that is going to prevent contagion and the spread of illness," she says. (Such distribution would only be possible in Ciudad Juárez, however, since it's illegal to distribute syringes in Texas.) "Another harm-reduction approach is distributing condoms to individuals who are at risk but also teaching them skills so that they can negotiate, for example, condom use with a partner."

Though crime has dropped in recent years, Ciudad Juárez suffered an unprecedented period of violence with drug cartels from 2008 to 2012. Murders were up. So were kidnappings. The crime wave also impacted public health. Epidemiological research conducted during the peak of the violence indicated that more people were engaging in sex work, that drug users were doing less to protect themselves against HIV and that police crackdowns were resulting in riskier behaviors among drug users.

As an example, Lechuga referenced a study of injection drug users in which half reported being arrested for possessing a syringe. Those arrested were twice as likely to report that they were sharing syringes and injecting in the street, according to the study. Participants also reported experiencing painful heroin withdrawal while jailed, then sharing syringes and injecting quickly after being released.

"We think of violence in terms of the crime problem, and we consider having more police officers or arresting more people," Lechuga says. "We don't think of the public health aspects of this."

In addition, many of the community centers in Ciudad Juárez that treated substance abuse and treated and prevented the spread of infectious diseases have closed—a result of people's attitudes toward drug users and harm-reduction approaches having soured, she says.

"It was like society took a step back," Lechuga says. "Without the resources and these approaches, we could be at the brink of an HIV epidemic in this area."

AFFECTING SOCIAL NORMS

Those who are highly addicted tend to be alienated from their families and tend to develop relationships with those in similar

A period of violence with drug cartels in Ciudad Juárez led to more people engaging in sex work and risky behavior among drug users.

situations, Lechuga says. As in San Salvador, the team will try to affect social norms so that high-risk drug users become better at protecting themselves against the other health ills.

"The underlying condition is the addiction itself, but many people are not ready to face their addiction," she says. "It's only until they are ready that they can take care of that, but they can do other things to help prevent something very bad from happening to them."

One man who had tested positive for HIV in San Salvador had been in shock at his status. Though project leaders made every effort to take him to the ministry of health for a confirmatory test and begin treatments, he left without getting additional help. However, a year later, Lechuga says, he returned.

"He said, 'I'm back, because when you told me my result, the only thing I wanted was to die. So I went out and started using more drugs, drinking more. And one of those days that I was on the streets, my head spinning, I just kept remembering the words you said to me: You deserve to live. You're a human being. Now I'm ready.' He followed up with the confirmatory test, treatment and interventions," she says.

"When I hear positive stories, it's what keeps me going."

In El Paso and Ciudad Juárez, Lechuga and her community partners have been conducting in-depth interviews and surveys with drug users to better understand living conditions and demographics. Where do people use drugs—at crack houses, in abandoned buildings, in their homes? Under what circumstances do they cross the border to use drugs? How often do they have sex, and with how many partners? What are some of the barriers they face in accessing health care? Do they have access to condoms and clean syringes?

Outreach workers will map the areas where people congregate to use drugs. "We want to get to the places where people will benefit the most," she says.

"IT WAS LIKE SOCIETY TOOK A STEP BACK," SAYS LECHUGA. "WITHOUT THE RESOURCES AND THESE APPROACHES, WE COULD BE AT THE BRINK OF AN HIV EPIDEMIC IN THIS AREA."

Next, the team will confer with its community advisory board members to decide how best to adapt the interventions used in San Salvador, where crack, not heroin, was the predominant drug.

"We're going to bring our findings to them, and we're going to say, 'Ok, this is our population. We have this intervention. What are we going to do?' And we're going to decide. Do we keep some activities? Do we modify some? What do we think will be the most successful?"

Education, though, will be key, so that drug users can learn about the effects of drugs on their brain and come to understand that addiction is not a moral failing but an illness, Lechuga says. Rapid HIV testing will be another harm-reduction strategy there.

"If medicine has advanced this far where we have HIV tests, where we have medication, but it's not getting to the people who need it most because of their social marginalization, that's a fundamental injustice. It's something that we can fix, and it's just wrong not to do it." ●

Addressing Heroin Addiction

The number of overdose deaths involving opioids, including heroin and prescription drugs, has quadrupled in the United States since 1999, according to the Centers for Disease Control. From 2000 to 2015, there were more than a half million overdose deaths.

To help reduce the negative health consequences of opiate abuse, the Neighborhood Health Centers of the Lehigh Valley (NHCLV) received funding from the Pennsylvania Department of Health to establish the Center of Excellence for Opiate Use Disorders, which will diagnose and treat individuals in the Lehigh Valley, Pa., area.

The center will implement a comprehensive treatment plan in which community health workers will conduct outreach and increase referrals of individuals with the potential disorder, diagnose, prescribe a new line of opiate substitute therapy and link individuals to other needed services.

Lehigh's Community Health Research Group—an interdisciplinary team of scholars including Julia Lechuga; Lucy Napper, assistant professor of psychology; Christopher Burke, associate professor of psychology; and Sirry Alang, assistant professor of sociology and anthropology—will collaborate in evaluating the efforts.

Lehigh awarded $40,000 to the group's researchers to assess the center's approach and determine what factors may be hindering or helping in achieving goals.

Each researcher will take on a different role. Lechuga will assess implementation by seeking input from community health workers, as well as making ethnographic observations of the workflow or series of steps needed to implement the treatment plan. Also, the researchers will assess protocols for recruiting patients, tracking and reporting visits, referrals and follow-up.

"As the United States grapples with the unprecedented increase in opiate abuse across several states, health authorities are moving steadfastly to implement innovative approaches to help curb the epidemic and reduce the negative health impacts often associated with substance abuse, including increased incidences of infectious diseases. Lehigh's research findings have the potential to inform an effective course of action for health institutions trying to implement similar efforts across the country."

CHEMISTRY

KNOW THINE ENEMY

In the battle against drug-resistant bacteria, Marcos Pires studies the chemical biology of bacterial cell surfaces to better understand how they function—and possibly how to manipulate them.

Alexander Fleming warned of the risk of antibiotic-resistant bacteria. Marcos Pires is tackling the ever-growing threat of drug resistance.

Written by
Kelly Hochbein

Illustration by
Hvass & Hannibal

Alexander Fleming discovered the original antibiotic, penicillin, completely by chance in 1928. Fleming later won a Nobel Prize for his discovery, which was considered a miracle drug. However, Fleming himself recognized the potential for the development of drug-resistant bacteria.

"I would like to sound one note of warning," Fleming said during his Nobel lecture in December 1945. "... It is not difficult to make microbes resistant to penicillin in the laboratory by exposing them to concentrations not sufficient to kill them, and the same thing has occasionally happened in the body."

Fleming went on to describe a hypothetical scenario in which "the ignorant man may easily underdose himself [with penicillin] and by exposing his microbes to nonlethal quantities of the drug make them resistant." If a man with a sore throat, "Mr. X," takes an insufficient amount of penicillin to kill the streptococci bacteria causing his infection, Fleming said, he allows the bacteria to develop a resistance to penicillin. When the man's wife, "Mrs. X," becomes infected by the same bacteria, penicillin treatment will be rendered ineffective and her infection may prove fatal.

"Who is primarily responsible for Mrs. X's death?" Fleming asked. "Why Mr. X, whose negligent use of penicillin changed the nature of the microbe. Moral: If you use penicillin, use enough."

Indeed, bacteria have evolved over time, limiting the effectiveness of penicillin and many other antibiotics. In the body, these drug-resistant bacteria survive antibiotic exposure and continue to multiply. According to the Centers for Disease Control and Prevention, more than 2 million people become infected with antibiotic-resistant bacteria each year, and approximately 23,000 of those die from these infections. The World Health Organization lists antibiotic resistance as one of the biggest threats to global health today.

Marcos Pires, assistant professor of chemistry, seeks to better understand the enemy in the fight against drug-resistant bacteria. He is tackling the problem of antibiotic resistance through the creation of synthetic amino acids intended to trick bacterial cells into using some of these unnatural building blocks instead of their own. Pires believes a potential line of defense may lie in how the microorganisms construct their peptidoglycan, or cell wall. The cell wall functions like a jacket that surrounds and protects bacteria from their surroundings.

"You really have to understand how bacteria are operating, and if you do, maybe you can find a way to disrupt it," he says.

BACTERIAL TRICKERY

In his initial work with bacteria, Pires and his team, inspired by the successful immunotherapy treatment of some cancers, exploited bacteria's unique use of D-amino acids to "trick" them into generating an *in vitro* immune response. Amino acids are the building blocks of all living organisms, and, unlike other cells, bacterial cells will incorporate D-amino acids into their cells from their external surroundings. Pires and his team created synthetic D-amino acids, tagged them with an antigen that draws a response from a pool of common human antibodies, and added the amino acids and the antibodies to a flask of bacteria. The bacteria then did the rest of the work. As they were growing, they were tricked into incorporating the lab-produced amino acids on their peptidoglycan, essentially marking themselves for destruction by the antibodies.

Pires described the results of this research in a 2014 article in The American

Marcos Pires' research interests include protein oligomerization, biomaterials, and multidrug resistance. Pires received his Ph.D. from Purdue University and completed his postdoctoral research at the University of Pennsylvania.

Chemical Society's *ACS Chemical Biology* titled "D-Amino Acid Mediated Recruitment of Endogenous Antibodies to Bacterial Surfaces," and in a 2016 *ACS Infectious Diseases* cover article titled "Dipeptide-Based Metabolic Labeling of Bacterial Cells for Endogenous Antibody Recruitment."

For this work, *ACS Infectious Diseases* in August 2016 named Pires a winner of its Young Investigator Award for "outstanding early career researchers."

Now, encouraged by his existing work, Pires is turning to the problem of antibiotic resistance and the role of the bacterial cell wall in its development. He uses bacteria's tendency to tweak their amino acids in response to antibiotics to once again "trick" them—this time into revealing information about themselves.

Many antibiotics operate by inhibiting how bacteria put together their cell wall, says Pires. In response, bacteria modify the amino acids, or "building blocks," on their cell wall to prevent the antibiotic from attaching to it.

"That's where we come in," explains Pires. "We make that different building block [in the lab] but with a marker [to track the change.] If we make it so it's not too disruptive, [the bacteria] thinks it's picking up its own building block. But it's picking up ours."

In the same way it did in Pires' earlier research, the bacteria then places the lab-produced amino acid on its cell wall. Pires and his team add an antibiotic and monitor the process, using the marked synthetic amino acids to note any changes in the cell wall.

"That allows us to essentially follow how—or how quickly—the bacteria is becoming resistant," he explains. "We are able to see basically how long this takes."

Surprisingly, it doesn't take very long for resistance to develop. Within an hour, says Pires, bacteria adapt to escape the antibiotic. However, as soon as the antibiotic is removed, the bacteria begins returning to its original state. This demonstrates, he says, that the resistant state is "really stressful to the cell."

The team has charted this process with various types of bacteria and antibiotics to determine which types of bacteria respond to which antibiotics and how. They work with four to five types of harmless bacteria, some of which are considered "model organisms." "Usually it's the case that [when] you find something about their physiology, it will be the same more or less for the pathogenic bacteria," says Pires.

Pires believes that knowledge about bacterial physiology might help in the development of an antibiotic that can overcome changes to the cell wall. The best defense, after all, is a good offense—and a clear understanding of the enemy.

"I think now that things are a little bit more dicey [with drug resistance] and we really haven't been able to come up with new antibiotics, there's almost a revival in this [interest in] how cells are putting together their cell walls. Maybe from this we can learn how to design a drug," he says.

Faster Diagnostics to Protect Existing Drugs

By the time a patient arrives at a hospital with a bacterial infection, it's often progressed significantly. The attending doctor can assume the bacteria is drug-resistant or wait the more than 24 hours it takes for a test to determine drug resistance. Because a delay could have catastrophic results, doctors often err on the side of caution and treat as if the bacteria is resistant, prescribing the last-resort antibiotic, which should only be given to truly drug-resistant infections.

"Doctors are really aware of the clock that starts once a patient shows up at the hospital, usually at a point that's already pretty advanced. So they decide to play it safe," says Pires. "If you do this enough there may not be a 'next drug' soon enough."

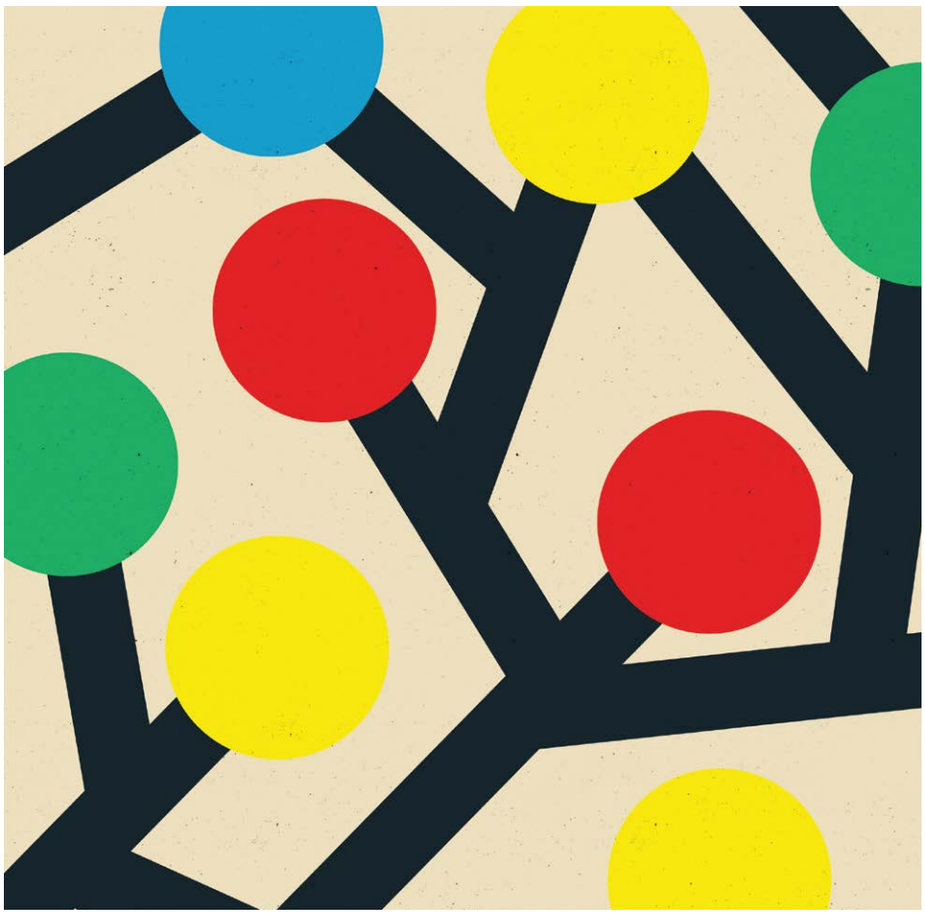
Pires' work in training bacteria to use unnatural amino acids has revealed a potential diagnostic application: a simple test that can determine, in a matter of hours, whether a particular bacteria will be drug-resistant and, if it is resistant, to which drug.

If a patient's symptoms make it clear that they're suffering from a bacterial infection, the next step is determining what type of bacteria is causing the infection. Even if doctors determine that with a test, the question of whether the particular strain is drug-resistant remains a guessing game.

"Knowing what you have doesn't really tell you if you have the drug-resistant version of it or the drug-sensitive one," says Pires. "It could be sensitive to your standard amoxicillin or it could be a resistant-across-the-board type of bacteria."

In Pires' diagnostic test, cells extracted from a patient are incubated with an unnatural, lab-created molecule. Within four hours, a drug-resistant strain of bacteria will utilize that molecule and place it on its cell wall. A dye injected into the flask will stick to the bacteria that has utilized the unnatural molecule, providing a "direct readout" that is specific to a particular type of resistance.

"The hope here is that from this test [doctors] know very quickly which antibiotic to give," says Pires.



ECONOMICS

THE NETWORK EFFECT

With support from the National Institutes of Health, Seth Richards-Shubik studies the impact of physician networks on treatment decisions.

An understanding of the role of physician networks can help determine effective interventions such as academic detailing.

Written by
Kelly Hochbein

Illustration by
Anna Kövecses

Physicians can have several options when prescribing medications to treat chronic conditions. How do they choose between a new, name-brand drug or a more familiar alternative? Physician decisions like these impact more than just patient outcomes: According to the Centers for Medicare and Medicaid Services, U.S. prescription drug spending in 2015 reached $324.6 billion.

"We have very large healthcare costs in this country and very rapid growth, and it's not necessarily bad," says Seth Richards-Shubik, assistant professor of economics. "Spending money on health is fundamentally a great thing. It saves lives. So it's a matter of controlling or improving it to the extent that we save as many or more lives, but perhaps we spend the money more efficiently."

Supported by a four-year, $3 million grant from the National Institutes of Health (NIH), Richards-Shubik and co-investigators from the University of Pittsburgh and Harvard University are trying to understand the role of physician networks in how doctors select patient treatment options.

In what Richards-Shubik calls an informational contagion, ideas spread across a network of physicians, who learn from one another about treatments and their benefits and risks. For better or worse, these interactions then influence the treatments those physicians choose and the drugs they prescribe.

Richards-Shubik and his colleagues are looking at five drugs, all introduced in recent years and used to treat cardiovascular disease or diabetes. Using prescription data for nearly all of Pennsylvania's 50,000 physicians as well as Medicare and Medicaid claims data for more than 2 million adults in the state, they are measuring the rate and speed of adoption of these drugs among these physicians. They are also examining the influence of various factors on physician adoption of new medications: physician characteristics, patient characteristics, institutions and different types of professional networks (those formed during training, at the same hospital or within the same medical group, and, in a more novel approach, those who share patients via referrals).

If you see enough common patients between two physicians, Richards-Shubik says, you can infer there is some kind of relationship between them. This establishes what's called a patient-sharing network.

"Once you have these networks, then quantifying the peer influence is a fairly straightforward application of econometric techniques," he explains. "What you're trying to do is take a particular physician's peers at the hospital and those that the physician shares patients with. What proportion of them have started prescribing the new drug? How does that influence the physician's own propensity to prescribe it?"

The team can then measure the strength of that influence and determine, based on that magnitude of influence and on the established network, the more influential players in the network.

"We're finding a big influence from the colleagues that physicians share patients with," says Richards-Shubik. "We're seeing ways where you could identify influential physicians even better using this network information."

Understanding the role of these physician networks can help determine effective interventions like academic detailing, which allows trained health-care professionals to educate prescribers about treatment options, potentially helping them make choices that could improve patient outcomes or reduce costs—or perhaps even both.

"I'm not saying this is an easy slam dunk," says Richards-Shubik. "But to me it's a very important road to try to go down." ●

Seth Richards-Shubik's research interests include health economics, applied econometrics and network models. He received his Ph.D. from the University of Pennsylvania.

MECHANICAL ENGINEERING & MECHANICS

HEALING BONE FASTER

Hannah Dailey's novel orthopedic device may revolutionize bone fracture recovery, improving patient outcomes and reducing costs.

Written by
Lori Friedman

To heal small bone fractures—like those in a wrist, finger or ankle—a cast or splint is usually all that is needed to promote regrowth. Once stable, the bone tissue—a living material—regenerates and heals.

Healing a break in a long bone—like the femur (thigh bone) or tibia (shin bone)—is a more complicated and much lengthier process. It can take four to six months—sometimes even longer—for a patient to return to full use of their legs after a traumatic incident.

Since the 1940s, surgeons have used a process called intramedullary nailing to heal long bone breaks. During this procedure, a specially designed metal rod is inserted into the marrow canal of the bone. The rod passes across the fracture to keep it in position and is screwed to the bone at both ends. As the bone tissue regrows, the rod holds the bone in place, directing where and how new bone tissue forms.

Device design improvements have focused on the mechanical environment at the fracture site to accelerate bone remodeling.

"When it comes to bone healing, extremes of both stability and instability can have a detrimental effect," explains Hannah Dailey, assistant professor of mechanical engineering and mechanics. "My focus is on improving patient outcomes by designing a rod that optimizes healing through micro-motion—a device that creates the ideal conditions at the fracture site to promote maximum healing."

Research has shown that axial movement—the movement of the rod up and down inside the bone—speeds healing. Unfortunately, an increase in such movement has also been associated with increased twisting motion, which has been found to slow healing.

Dailey and her colleagues have developed a technology that achieves the ideal combination: increased axial motion that speeds healing with minimal torsional, or twisting, movement. The device is called a Flexible Axial Stimulation (FAST) intramedullary nail. Known commercially as the Apex Tibial Nail System from OrthoXel, FAST has the potential to revolutionize bone fracture recovery.

A revolution in orthopedic medicine is on the agenda at OrthoXel, the medical device start-up that Dailey co-founded and where she serves as Chief Scientific Officer. The company seeks to develop and commercialize orthopedic devices that improve patient outcomes, increase surgeon accuracy and efficiency, and reduce costs to patients and the health care system. The Apex Tibial Nail System is the first OrthoXel device to hit the market.

The device is the result of a five-year research and development process led by Dailey and colleagues at the Cork Institute of Technology in Ireland, who oversaw all aspects from conceptual ideation through a large-animal preclinical study.

She and her team undertook a proof of concept study that demonstrated support for the development of a micro-motion-enabled intramedullary nail. Notably, the study suggested that when compared to rigid-fixation nails—which require significant weight-bearing to induce the interfragmentary motion that promotes healing—the micromotion-enabled nail was likely to allow movement in non-weight bearing patients during the early healing period. The early recovery stage is when the benefits of mechanical stimulation at the fracture site are most critical.

> "WE ARE NOT ONLY OFFERING SOMETHING NEW TO SURGEONS... WE ARE ALSO REDUCING COSTS TO PATIENTS AND THE HEALTH CARE SYSTEM—ALL THROUGH MEDICAL DEVICE DESIGN."

Later, the team published the results of a comprehensive biomedical study showing that the device provided controlled axial motion at the fracture site while retaining high torsional stability—the ideal combination to enhance healing.

Finally, preclinical trials on the micro-motion-enabled tibial nails produced successful healing, and provided strong safety evidence *in vivo*—paving the way to the development of the commercial product now marketed to surgeons. The team is also working on an Apex Femoral Nail System to provide solutions for additional fracture types. ●

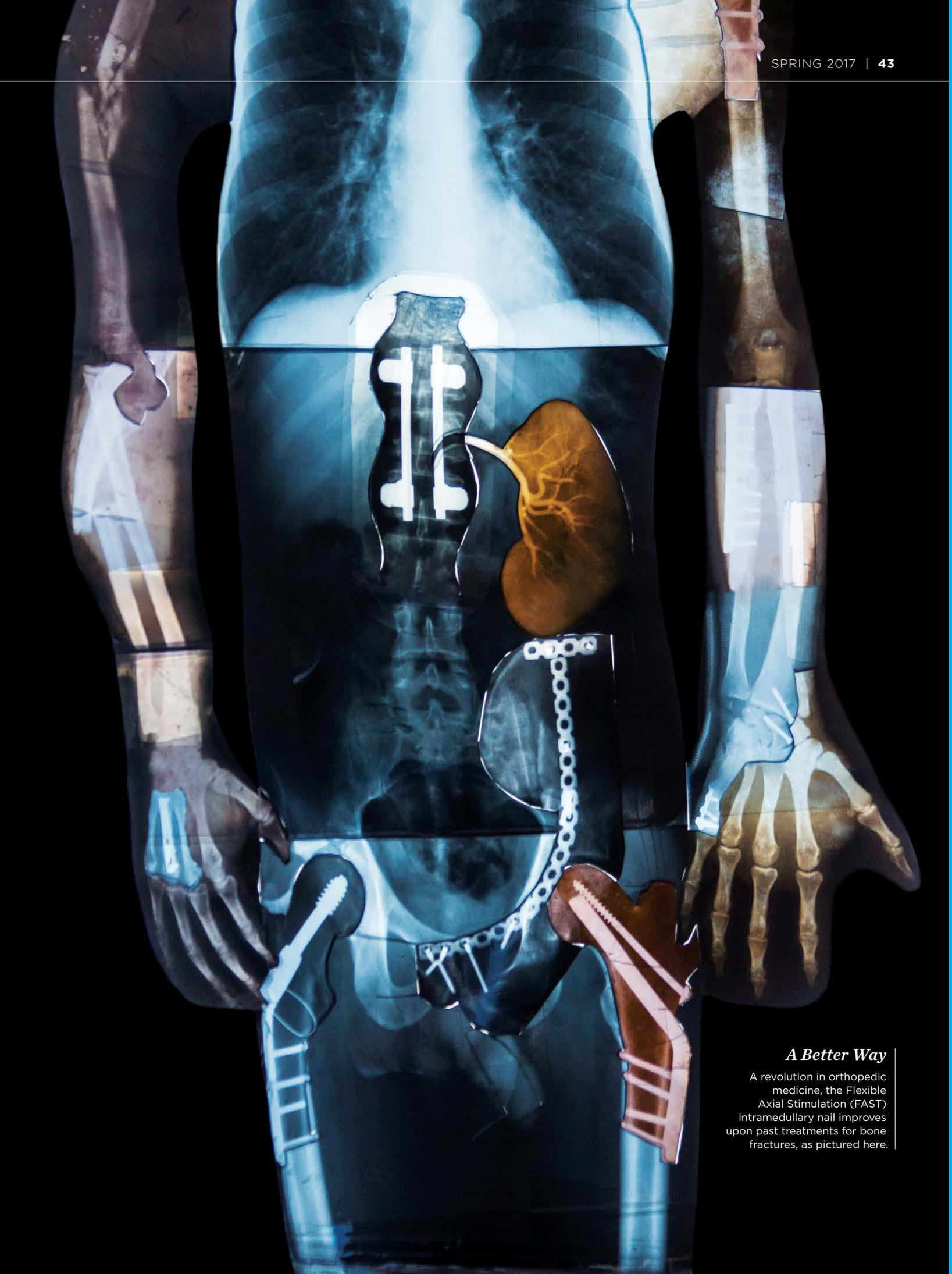
3-D Printing Tissue

Lesley Chow, assistant professor of materials science and engineering and bioengineering, and Dailey are collaborating to create biodegradable 3-D-printed biomaterials for musculoskeletal tissue regeneration. They are fabricating scaffolds—highly-porous structures that provide a template for the body to regrow tissue. While others focus on growing tissues in a lab from patients' cells, Chow and Dailey are creating implantable scaffolds to guide tissue regeneration inside the body.

The Chow lab creates libraries of bioactive inks (bio-inks) that can be 3-D printed together into a scaffold that mimics the biochemical organization of native tissues. By changing the scaffold's physical structure and porosity, the Dailey lab aims to recapitulate the mechanical properties of native tissues. The collaborative team explores how the combination of biochemical and mechanical information "coaxes" stem cells to behave in specific ways.

The ultimate goal is to instruct multiple cells to perform multiple functions—all in one construct. Ideally, this will regenerate more functional tissues to replace damaged or diseased ones inside the body.

Hannah Dailey received her Ph.D. from Lehigh University and was then a postdoctoral research engineer in the Medical Engineering Design and Innovation Centre (MEDIC) at the Cork Institute of Technology in Cork, Ireland. She now serves as Chief Scientific Officer for OrthoXel, DAC, an Irish-based startup orthopedic trauma company that was honored as emerging company of the year at the Irish Medtech CEO Forum.



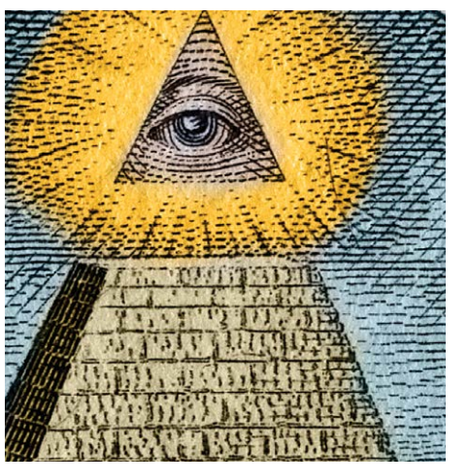
A Better Way

A revolution in orthopedic medicine, the Flexible Axial Stimulation (FAST) intramedullary nail improves upon past treatments for bone fractures, as pictured here.

PSYCHOLOGY

THE TRUST GAP

A lack of trust might prevent even the most egalitarian individual from behaving in a completely egalitarian way. Dominic Packer studies the relationship between trust and bias.



Written by
Kelly Hochbein

Over the past half-century, the United States has seen steady declines in public levels of prejudice toward minority groups, says Dominic Packer. However, disparities between racial groups haven't shifted much. If attitudes about equality have seemingly changed, why wouldn't behaviors change as well?

One popular explanation for this circumstance is the notion of implicit bias, or rapid evaluative responses: unconscious and automatic negative attitudes that affect how we think, speak and act with regard to characteristics such as race or ethnicity. Packer, associate professor of psychology, is exploring an alternative explanation: the trust gap.

People, Packer says, are more inclined to trust members of a group with which they affiliate and less inclined to trust someone from a group other than their own. Packer calls this the trust gap, and he says it might be bridged with mechanisms that help build trust and increase people's willingness to work outside their own groups. At the societal level, these mechanisms are social institutions like government, law enforcement, the criminal justice system and the media. If effective, says Packer, these external mechanisms can support cooperation between individuals and reduce preferences for "ingroup members." However, as overall trust in the the United States' major institutions has declined dramatically, the trust gap could have significant ramifications for intergroup relations.

DECLINING TRUST, INCREASING BIAS

Packer and his team have found that the more people trust in social institutions, the less preferential bias they exhibit in everyday life. In a series of three studies described in a paper titled "Dynamic tuning of evaluations: Implicit racial attitudes are sensitive to incentives for intergroup cooperation," he and graduate student Shiang-Yi Lin assigned participants to artificial groups and told them they would be playing trust games with members of their own group versus another group. The participants, who were all white, were shown photographs of the black and white individuals who would play the games with them, aware that they would have to decide whether or not to trust their partners.

In one version of the study, Packer and Lin created an external institution, or "punisher," who, they told participants, would monitor the games and either punish unfair behavior in one condition or reward fair behavior in another condition. Participants, in this case, understood that the punisher provided their partner, regardless of group affiliation, with an incentive to behave appropriately. Prior to playing the games, Packer and Lin had participants complete an implicit bias measure toward black and white faces.

"What we find is that if participants think they're going to play these trust games and that's it, there's no punisher present, then we see the standard, pro-white bias on the measure among our white participants," says Packer. "But if they believe they can play the games later and there's going to be a punisher present, then that pro-white bias is gone."

Similarly, says Packer, if social institutions, society's "punishers," are deemed corrupt or unworthy of trust, bias increases. If a society feels unsafe, says Packer, "you're going to choose to rely on the people you either know personally or at least you have some common identity with because they'll be more likely to treat you well."

Packer believes this might explain why disparities between groups in the U.S. have not changed, despite a decline in public levels of prejudice.

A June 2016 Gallup poll of confidence in institutions revealed that the overall average of Americans expressing "a great deal" or "quite a lot" of confidence in U.S. institutions is at just 32 percent. Nearly all American institutions have been experiencing a steady decline in confidence. Confidence in Congress, for example, has dropped to 9 percent.

These overall low levels of confidence might be making Americans more insular, says Packer. Although variation does exist by community and between individual people, if an individual no longer trusts social institutions to regulate society, that individual will find other means. Turning inward is one path they might take.

"It's just easier to trust in-group members, so you end up defaulting to that even though you value equality. … If you add that up across lots of interactions, you could still have a great deal of discriminatory outcomes even though you've got a lot of positively motivated people," says Packer.

Dominic Packer is an associate dean for research and graduate programs in the College of Arts and Sciences. He received his Ph.D. from the University of Toronto and completed his postdoctoral studies at the Ohio State University. Packer's research examines the social cognitive and neural processes that support collective life.

Influencing Bias

If study participants believed an unbiased, external "punisher" would monitor participant behavior during trust games, their pro-white bias disappeared, says Packer. Without a punisher, the bias remained.

CHEMICAL & BIOMOLECULAR ENGINEERING

ENGINEERING CELLS TO SPEED TISSUE REPAIR

Kelly Schultz explores how cells remodel their microenvironment in a push toward faster wound healing and tissue regeneration.

Replacing and repairing human tissue is becoming feasible largely due to advances in the use of stem cells. But obstacles still stand in the way of engineering these malleable cells to self-renew or expand.

One of those obstacles is an incomplete picture of how cells interact with their environment.

"Cells do not simply reside within a material, they actively reengineer it," says Kelly Schultz, the P.C. Rossin Assistant Professor of Chemical and Biomolecular Engineering. "Characterizing how cells behave in 3-D synthetic material is critical to advancing the design of biomaterials used in wound healing, tissue engineering and stem cell expansion."

Schultz recently received a three-year grant from the National Institutes of Health (NIH) to study how cells remodel their microenvironment—a crucial step toward engineering cells to move through synthetic material and tissue more quickly for faster wound healing and tissue regeneration.

Schultz will build on previous work in which she and her colleagues revealed that during attachment, spreading and motility, cells degrade material in the pericellular region directly around the cell in an entirely different manner than researchers had previously believed. The results were published in an article in the *Proceedings of the National Academy of Sciences (PNAS)*.

Before Schultz's earlier study, scientists believed cells moved through material while simultaneously degrading it—like Pac Man gobbling up dots while moving through a video game maze.

Utilizing microrheology, a technique that measures the properties and states of matter, Schultz and her colleagues made a discovery that overturned this notion. After encapsulating mesenchymal stem cells in a hydrogel, the team measured dynamic interactions between the cells as they moved through material.

They made an unexpected observation: the cells pause before moving. They discovered that from a stationary position, Point A, a given cell secretes an enzyme. They hypothesize that the enzyme is bound with an inhibitor that temporarily stops the enzyme from degrading the material while it's being sent to Point B. Starting at Point B, the enzyme begins to "gobble up" the material that surrounds the cell. Only then does the cell move on to its next location.

The inhibitor, the team observed, prevents the enzyme from degrading the material while the cell is secreting it.

Armed with this information, Schultz and her team now aim to "inhibit the inhibitor." That is, they seek to identify which inhibitor, or combination of inhibitors, is responsible for stopping the enzyme from degrading the material while it's being secreted. Once identified, the researchers hope to "tune" the inhibitor to shut off during secretion so that the cell will move through and degrade the material faster.

Engineering the cell to move faster is important for wound healing, Schultz says. The sooner the cells arrive at the wound site, the sooner they can start to regenerate the tissue.

"Our goal is to prevent the cell from stalling, encouraging it to become active right away and arrive at the wound site at twice the speed," says Schultz.

A SCAFFOLD TO MIMIC BONE

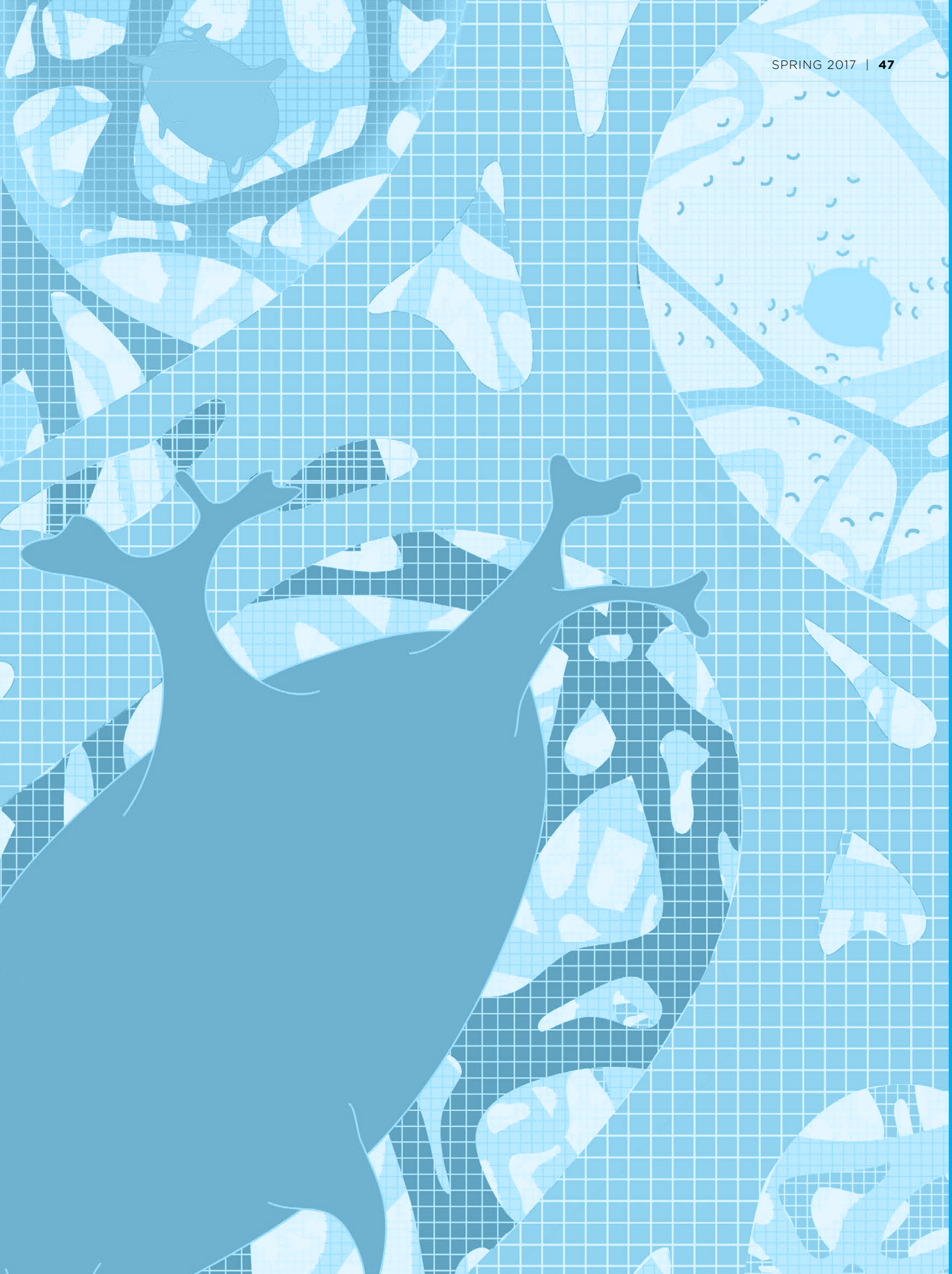
With broad implications for biomaterial design, Schultz's project will focus on a

Schultz encapsulates adult stem cells in a hydrogel with a grid-like matrix that the cell enzymes (below, in red) break apart. When holes form, the markers have room to wiggle. Once the cell has redesigned its space, it can easily move through the hydrogel.

Written by
Lori Friedman

Illustration by
Nicolle R. Fuller

Kelly Schultz's research interests include characterization of synthetic biocompatible hydrogel scaffolds, high-throughput screening of three-dimensional cell encapsulation within a synthetic scaffold, and characterization of cell-mediated degradation during encapsulation. She received her Ph.D. from the University of Delaware.



range of tissues, from adipose to bone, to measure how changing the physical environment might alter the strategies cells use to degrade the material. She works with mesenchymal stem cells—a type of adult stem cell that has the ability to differentiate into a variety of cell types.

Hydrogel offers two advantages. First, it mimics tissue well, providing an ideal physical environment to characterize cell behavior in 3-D. Hydrogels are more than 90 percent water, are very porous and can be "tuned" to change properties to mimic anything from bone to fat.

Second, once the hydrogel is implanted in a human, it can be used as a scaffold to restructure a wound of a size that the body cannot heal.

"For example, if a patient is missing a piece of bone that is too large to heal—or regenerate—on its own, a hydrogel structure can be implanted," says Schultz. "Inside the structure are stem cells that have been given an environment that would push them down a lineage into bone cells. Once implanted the stem cells reproduce themselves, 'filling in' the part of the bone that is missing. While the bone is growing outside the implant, new tissue is growing on the inside—speeding healing. As the bone regenerates, the implant disintegrates."

To make the hydrogel structures, Schultz mixes polymers, peptides, stem cells and microparticles. The microparticles enable the material properties of the hydrogel to be measured during cell-mediated degradation.

"We take videos of the microparticles and observe their movement," says Schultz. "The amount they wiggle reveals their properties and enables us to see spatially what's occurring. That is how we characterized the unexpected degradation profile."

"INHIBITING THE INHIBITOR"

The recording process described above is known as multiple particle tracking microrheology. This same method will be used to identify the role of inhibitors.

Cells secrete four different enzyme inhibitors, called tissue inhibitor of metalloproteinases (TIMPs). The researchers will inhibit each to discover which one is responsible for stopping the material degradation, or if it is a combination of them.

Schultz and her collaborators will also mimic diverse tissue types in order to observe how the inhibitors might change depending on the material.

Schultz's studies will focus on the remodeling of synthetic scaffolds by human mesenchymal stem cells. The techniques and strategies she and her team develop are expected to contribute to the understanding of cell-material interactions and to identify how these interactions can be exploited to manipulate cellular behavior for 3-D cell culture platforms and tissue regeneration applications.

"WHILE THE BONE IS GROWING OUTSIDE THE IMPLANT, NEW TISSUE IS GROWING ON THE INSIDE—SPEEDING HEALING. AS THE BONE REGENERATES, THE IMPLANT DISINTEGRATES."

AMONG THE NATION'S BRIGHTEST

Schultz is one of engineering's rising stars, according to the prestigious National Academy of Engineering (NAE).

She participated last fall in the NAE's 22nd annual U.S. Frontiers of Engineering (USFOE) symposium. The symposium recognizes engineers ages 30-45 who are performing exceptional research in a variety of disciplines. Schultz was one of 83 engineers from industry, academia and government to be nominated and selected for the impact of their work.

"The USFOE symposium gives our nation's brightest younger engineers the opportunity to engage, collaborate, and develop long-term relationships that are critical to advancing our nation's future," said NAE President C. D. Mote, Jr. in a statement.

Engineering a Better Laundry Pod

Schultz is working with engineers at Procter & Gamble to improve its signature laundry detergent, Tide Pods. The popular single-use laundry soap is wrapped in disposable, water-soluble packets made with a rheological modifier (to control viscosity) called hydrogenated castor oil. This dynamically evolving gel material is safe, naturally-derived and used in many commercial products including household cleansers and cosmetics. Using multiple particle tracking microrheology, Schultz and her colleagues are working to characterize the complex properties of the material as it undergoes critical transitions, such as dilution.

"We are looking at how the material expands when it makes contact with water as well as the other ways the material properties change," says Schultz.

Hydrogenated castor oil gels evolve heterogeneously. This means that while the gel forms and degrades, it continues to be made up of discernible and non-uniform microenvironments distributed within the gel. The team's most recent work characterized the gel's heterogeneity through space and time during key transitions—as its network structure associates and then disassociates.

Ultimately, this quantification process could lead to the creation of a laundry soap pod that uses less material and is, therefore, more eco-friendly. Schultz's pioneering approach to characterizing material is also providing a new toolbox of techniques to measure the material properties of other heterogeneous environments using multiple particle tracking microrheology.

JOURNALISM

STREAMING JUSTICE

Although Facebook Live and other livestreaming services offer citizens a way to question and hold authority accountable, they can also be used to showcase darker impulses and motives, says Jeremy Littau.

(Above) A man protesting the shooting death of Alton Sterling is detained by law enforcement in Baton Rouge, Louisiana.

Written by **Linda Harbrecht**

Photo by **Jonathan Bachman**

In early 2017, a group of four Chicagoans tormented and tortured a mentally disabled boy and streamed a 30-minute segment of the horrifying acts through Facebook Live, arguably showcasing humanity at its worst. But the images also presented scholars such as Jeremy Littau, assistant professor of journalism, an unwelcome glimpse into the ways the new and still-evolving media tool is having an impact far beyond the news media.

Within the past year alone, viral videos of fatal police shootings of Alton Sterling in Louisiana and Philando Castile in Minnesota helped social justice advocates make the case that often-fatal shootings of African American men by police officers were happening with disturbing regularity—and that the preceding series of events were not often as clear-cut as they were described by the officers.

"Increasingly, we are seeing Facebook Live being used to hold people in power accountable," says Littau. He and Daxton Stewart, associate dean and associate professor in the Bob Schieffer College of Communication at Texas Christian University, recently published a study in the *Journalism and Mass Communication Quarterly*. "Up, Periscope: Mobile Streaming Video Technologies, Privacy in Public, and the Right to Record" examines the legal rights of individuals to record and live-stream events, as well as the potential right to be recorded and streamed in public places.

Calling the Facebook Live broadcast of the Castile shooting a "harbinger of what's to come," Littau says that social media users are becoming increasingly savvy about the impact these broadcasts can have.

"You particularly see that in the second half of the last year," he says. "More people were coming to see Facebook Live as a tool with the potential for some important uses, such as giving people a voice. It had a snowball effect for all sorts of reasons, both good and bad."

Within the normal media process, Littau says, the Castile shooting would have been logged in a police blotter, which would have most likely prompted a reporter to write a piece within 10 to 20 hours that included impressions of victims, witnesses and police spokespeople.

"The story would be more distilled, more nuanced," he says. "With Facebook Live, it's more raw, and it puts the power in the hands of people who aren't necessarily trained reporters, but are in effect, citizen reporters."

The method has its drawbacks, of course.

"The nuance is stripped away and you only see where the camera is pointing, and there is no context, which has its own set of complications. When you see something that you are trained to accept—you know, seeing is believing—without the context, it changes the interpretation," he says.

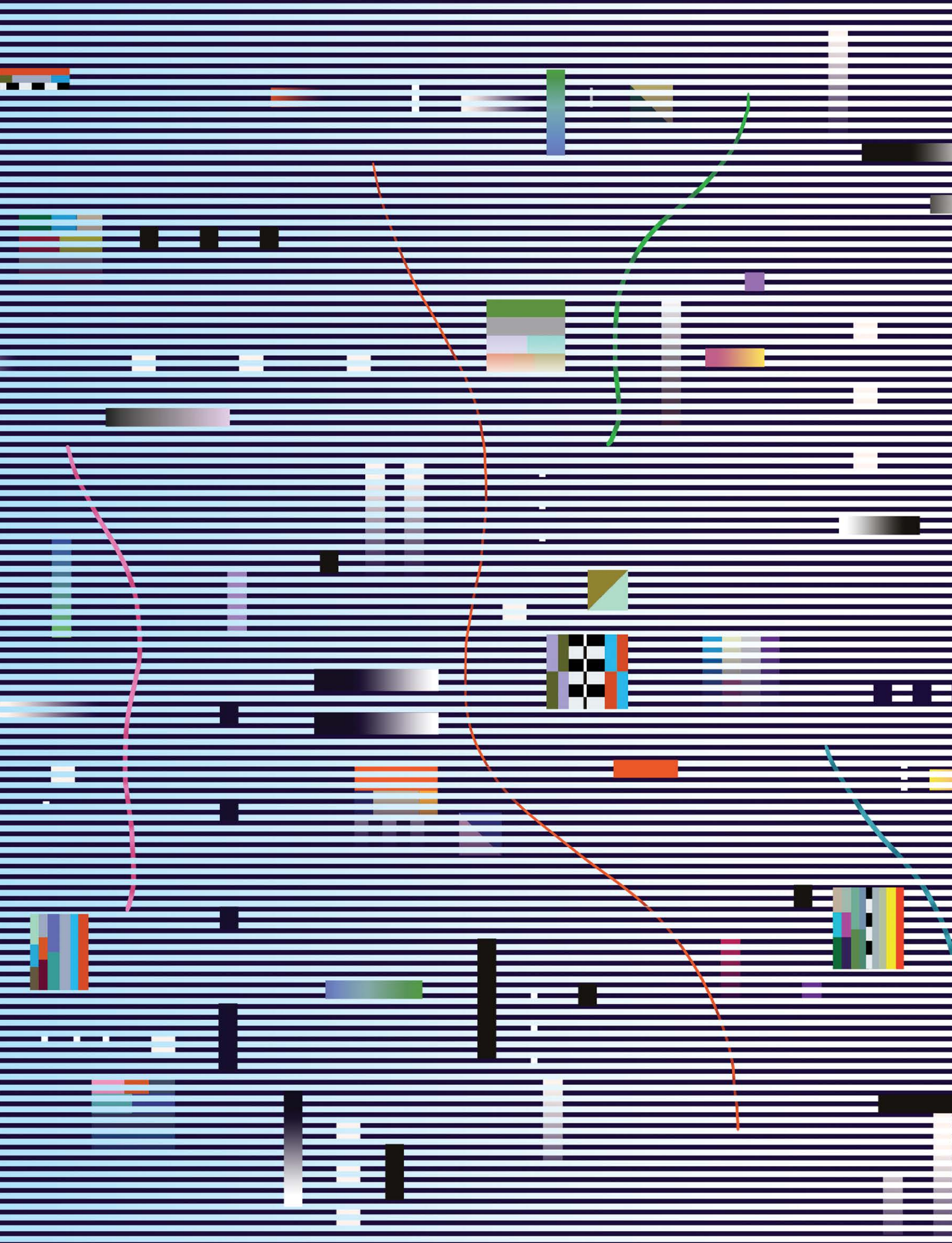
The power of visual images can be easily exploited to sway public opinion, and Littau says he is concerned about those who deliberately provoke confrontations for personal or political gain, or who have an interest in spreading fear like a contagion.

"The reality is," he says, "that there is now the capacity to create these moments with less time to not only absorb the information, but view them with a discerning eye. And if someone's goal is to spread terror, for example, we now have this communication platform that easily provides the means to do that, and achieve that type of immortality that some people seek."

Littau notes that some hate groups have quickly become proficient in harnessing social media to spread their messages and expand their base. In some cases, he says, "it has allowed them to organize very effectively and actually become more mainstream."

Dissident groups push the edge, he says. "And, for better or worse, the edges are where most advances in media technology are happening."

Jeremy Littau's research centers at the intersection of social media, community, social action and political engagement. Littau received his Ph.D. from the Missouri School of Journalism.



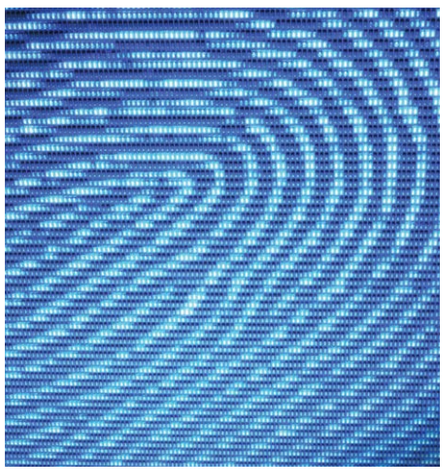
COMPUTER SCIENCE

MACHINE UNLEARNING

Yinzhi Cao seeks a faster and more effective way to protect data by helping machine learning systems forget.

Machine learning systems are everywhere. They predict the weather, forecast earthquakes, provide recommendations based on the books and movies we like, and even apply the brakes on our cars when we're not paying attention.

To do this, software programs in these systems calculate predictive relationships from massive amounts of data. The systems identify these predictive relationships using advanced algorithms and "training data." This data is then used to construct the models and features that enable a system to determine the latest best-seller you wish to read or to predict the likelihood of rain next week.



Cao and Junfeng Yang of Columbia University have received a $1.2 million NSF grant to develop their concept.

Written by **Lori Friedman**

Illustration by **Hvass & Hannibal**

This intricate process means that a piece of raw data often goes through a series of computations in a system. The computations and information derived by the system from that data together form a complex propagation network called the data's "lineage." The term was coined by Yinzhi Cao, assistant professor of computer science and engineering, and his colleague, Junfeng Yang of Columbia University, who are pioneering a novel approach to make learning systems forget.

Widely used learning systems such as Google Search are, for the most part, only able to forget a user's raw data—and not the data's lineage—upon request. This is problematic for users who wish to ensure that any trace of unwanted data is removed completely, and it is also a challenge for service providers who have strong incentives to fulfill data removal requests and retain customer trust.

Considering the importance of increased security and privacy protection, Cao and Yang believe that easy adoption of forgetting systems will be increasingly in demand. The two researchers have developed a way to do it more quickly and effectively than can be done using current methods.

Their concept, called "machine unlearning," is so promising that Cao and Yang have been awarded a four-year, $1.2 million National Science Foundation grant to develop the approach.

"Effective forgetting systems must be able to let users specify the data to forget with different levels of granularity," says Cao, a principal investigator on the project. "These systems must remove the data and undo its effects so that all future operations run as if the data never existed."

ENHANCING SECURITY

Building on work that they presented at the 2015 Institute of Electrical and Electronics Engineers (IEEE) Symposium on Security and Privacy, Cao and Yang's "machine unlearning" method is based on the fact that most learning systems can be converted into a form that can be updated incrementally without costly retraining from scratch.

Their approach introduces a layer of a small number of summations between the learning algorithm and the training data to eliminate dependency on each other. So, the learning algorithms depend only on the summations and not on individual data. Using this method, unlearning a piece of data and its lineage no longer requires rebuilding the models and features that predict relationships between pieces of data. Simply recomputing a small number of summations would remove the data and its lineage completely—and much more quickly than through retraining the system from scratch.

Cao believes he and Yang are the first to establish the connection between unlearning and the summation form.

And it works. Cao and Yang tested their unlearning approach on four diverse, real-world systems: LensKit, an open-source recommendation system; Zozzle, a closed-source JavaScript malware detector; an open-source OSN spam filter; and PJScan, an open-source PDF malware detector.

The success of these initial evaluations sets the stage for the next phases of the project, which include adapting the technique to other systems and creating verifiable machine unlearning to statistically test whether unlearning has indeed repaired a system or completely wiped out unwanted data.

In their paper's introduction, Cao and Yang write that "machine unlearning" could play a key role in enhancing security and privacy and in our economic future:

"We foresee easy adoption of forgetting systems because they benefit both users and service providers. With the flexibility to request that systems forget data, users have more control over their data, so they are more willing to share data with the systems. More data also benefit the service providers, because they have more profit opportunities and fewer legal risks.

"We envision forgetting systems playing a crucial role in emerging data markets where users trade data for money, services, or other data because the mechanism of forgetting enables a user to cleanly cancel a data transaction or rent out the use rights of her data without giving up the ownership."

Yinzhi Cao's research focuses on the security and privacy of the web, smart phones and machine learning. He received his Ph.D. from Northwestern University.

Playing with Language

The first chapter of Lay's book discusses how dialogue in William Shakespeare's *Measure for Measure* points to questions raised by Catholics at the time.

ENGLISH

BEYOND THE CLOISTER

Jenna Lay examines the spiritual guides, confessions and other writings by Catholic women in the century following the English Reformation.

Beyond the Cloister, Lay's first book, was published in 2016 by the University of Pennsylvania Press.

Written by **Kurt Pfitzer**

Illustration by **Laurindo Feliciano**

In 1534, one year after his marriage to Anne Boleyn and his excommunication from the Roman Catholic Church, King Henry VIII became the supreme head of the new English Church through an act of Parliament. Over the next seven years, Henry VIII closed all of the Catholic monasteries and religious houses in England and confiscated their land and wealth.

Following the dissolution of the monasteries, says Jenna Lay, associate professor of English, some nuns remained in England and others went into exile. By the latter half of the 16th century, women who remained Catholic or converted to Catholicism often practiced their faith as recusants—individuals who refused to attend English church services. Others left for Europe to set up convents in the Netherlands, France and Spain. The exodus grew as the pace of persecution quickened under Queen Elizabeth I.

These recusants and nuns, says Lay, wrote spiritual guides, confessions, prayers, polemics and hagiographies. They wrote to raise money, to answer their critics, and to take part in the political and religious debates of the day. But their contributions to English literature have been largely forgotten.

Lay attempts to restore the literary record in her new book, *Beyond the Cloister: Catholic Englishwomen and Early Modern Literary Culture*.

Lay spent a decade conducting research for her book, visiting monasteries and libraries in the United States and England and on the European continent, and poring over original manuscripts written in the convents. She became interested in her subject when she discovered that nuns often appeared in works by William Shakespeare, Christopher Marlowe, John Donne and other famous English writers in the decades following the dissolution of the monasteries.

"I wondered why these canonical writers were still interested in nuns if there were no longer any nuns in England," she says. "I did some initial research and learned that [in the decades following the English Reformation] there were still many Catholic women in England and on the continent. I became interested in how English authors were responding to the contemporary reality of Catholic women and their literary involvement in the period."

The four chapters of *Beyond the Cloister* discuss topics ranging from Shakespeare's dark comedy, *Measure for Measure*; Gertrude More, a contemplative nun and great-great-granddaughter of Sir Thomas More who helped found a Benedictine abbey in France and wrote a series of contemplations on her spiritual practices; and George Puttenham, author of *The Art of English Poesy*, whose private life underscores the ambiguities of the roles played by Catholic women in English literary history.

In a chapter titled "To the Nunnery: Enclosure and Polemic in the English Convents in Exile," Lay looks at the prosperous English monastery, Syon Abbey. Founded by Henry V in 1415, Syon became a public center of English literary life and, says Lay, a "lightning rod for Protestant propagandists." Following the dissolution, the monastery was demolished, and some of its nuns left for Europe, settling eventually in Lisbon, which was then part of Spain.

The nuns of Syon Abbey published manuscripts and printed books describing their travels and persecutions. While doing research in the British Library, Lay came across a manuscript the nuns wrote in response to an exposé about their Lisbon convent.

The exposé was written and distributed in 1622 by a Protestant propagandist named Thomas Robinson. Robinson, who had been a guest of the Syon nuns, claimed that priests and nuns were sleeping together at the monastery and that they had had babies and buried them in the monastery walls.

Within seven months of the publication of Robinson's pamphlet, the Syon nuns had written what Lay calls a "point-by-point takedown" of his claims. They accused him of lying and said he had been a pirate before becoming a writer of exposés.

In the nuns' manuscript, an allegorical character called Truth responds to Robinson's claims in one extended section; the other sections are written in the first person plural. The document was not signed, suggesting it was a collective effort.

"The response shows a rhetorical and literary sophistication on the part of the nuns," says Lay. "It shows that they could respond to Robinson in an exciting, flexible and sophisticated way."

Lay has received praise for her use of original source materials.

"*Beyond the Cloister* is an articulate and well-balanced contribution to a rapidly developing interest in early modern studies," wrote Lowell Gallagher, an English professor and literary theorist at UCLA. "The work represents a timely and valuable reminder of the critical dividends that a genuinely materialist approach to literary history can produce."

Jenna Lay's research focuses on early modern English literature, with specific attention to post-Reformation religious culture, poetry and poetics, female authors, and the intersection of manuscript and print technologies. Lay received her Ph.D. from Stanford University and completed a postdoctoral fellowship at the University of Texas at Austin.

A REVELATION BUBBLES UP

By calculating the ratio between vesicle sizes at the top and bottom of a lava flow, and relating this to the flow's thickness and age, Dork Sahagian determines the atmospheric pressure and elevation at which the lava emplaced.

Written by **Kurt Pfitzer**

Back when he was working on his Ph.D. in geophysics at the University of Chicago in the 1980s, Dork Sahagian took a break one day from studying lava flows to attend a lecture on how raindrops form in clouds.

What he learned gave him a fresh perspective on lava and inspired him to develop a new method of estimating the historic elevation of the Earth's land surfaces.

"At the lecture," says Sahagian, who is now a professor of earth and environmental sciences at Lehigh, "an atmospheric physicist showed how larger raindrops fall faster because they have a greater volume-to-surface-area ratio and thus a higher terminal velocity than smaller raindrops.

"Because of this, the larger drops catch up to the smaller drops and coalesce with them. The raindrops then grow in size, causing the size distribution to get bigger."

At the time, Sahagian was studying the vesicles, or air bubbles, that become suspended in the hardened flows of basaltic lava, a highly fluid form of molten rock spewed by volcanoes. The vesicles form and are trapped in the top and bottom layers of the lava flow; the middle layer, the last to solidify, remains bubble-free.

The physicist's lecture led to a Eureka moment for Sahagian.

"I turned the heavens upside-down, so to speak," he recalls. "I imagined the larger lava bubbles flowing upwards, like the bubbles in champagne or soda, and catching up to the smaller bubbles and then coalescing and rising faster still."

The top and bottom layers of the lava, Sahagian assumed, should contain roughly the same sizes of bubbles and the same distribution of bubble sizes. He did some mathematical calculations and wrote a model describing the rise, growth and coalescence of bubbles in a lava flow.

"But then one day I realized that the size distribution of the bubbles at the top of the flow should differ from the distribution at the bottom even though the lava comes from the same volcanic magma," he said. "That's because at the top, the bubbles are subjected only to atmospheric pressure,

(Right) A vesicular basalt from the upper vesicular zone of a relatively thin lava flow

while at the bottom, they're subjected to atmospheric pressure as well as to the hydrostatic pressure from the weight of the lava above."

Thus, Sahagian reasoned, by calculating the ratio between modal bubble size in the top and bottom layers of the lava, and relating this to the thickness and the age

Dork Sahagian's research interests include volcanology, tectonics, sea level, science education, and the environmental impacts of human activities. He served as an author and reviewer for the various Assessment Reports of the Nobel Prize winning Intergovernmental Panel on Climate Change (IPCC). He received his Ph.D. from the University of Chicago.

A Volcano's Clue

An erupting volcano under a night sky. Sahagian studies lava flows to estimate the historic elevation of the Earth's land surfaces.

of the lava flow, he could determine the atmospheric pressure that prevailed when the lava emplaced, or hardened into its final position. (The modal size is the size range with the greatest population of bubbles.)

"In other words, the ratios of the volumes of the bubbles should be the same as the ratio of the pressures. If we can measure the bubble volumes and the thickness of the lava, we can solve for atmospheric pressure."

And given that atmospheric pressure is a function of elevation—that it declines as a function of increasing elevation—Sahagian further deduced that it should be possible to determine at what elevation the lava emplaced.

Several years later, Sahagian, by this time a faculty member at Ohio State University, headed to Hawaii to test the formula in basaltic lava flows that had hardened during the 1959 eruption of Mauna Loa volcano. "When in doubt," he says, "go to Hawaii."

Sahagian is part of an interdisciplinary team of two dozen researchers that has spent seven years studying the Hangay Mountains of central Mongolia.

FROM HAWAII...

Sahagian and his student, Joe Maus, measured bubble sizes and distribution in samples taken from the base of Mauna Loa at sea level and from its summit at 12,000 feet elevation. To avoid skewed results, they sampled only simply emplaced, well-preserved and exposed lava flows that had not been altered—through inflation or drainage—after the upper and lower parts of the flows had solidified.

"We did a lot of scouting around before we found the right kind of flows," Sahagian says. "We wanted to make sure that the vesicularity we measured was truly a function of stratigraphic position in the flow."

The researchers calculated the ratio between average bubble size in the top and bottom layers of the lava at the base of Mauna Loa and then determined the same ratio for the lava at the volcano's summit. The difference between the two ratios was significant, and it corresponded roughly to the difference in atmospheric pressure between the summit and base of Mauna Loa. Sahagian and Maus reported their results in *Nature* magazine in 1994.

"If atmospheric sea-level pressure is known (or assumed)," they wrote, "vesicle size distributions in basalt flows can thus be used as an indicator of the paleoelevation of emplacement. Analysis of the vesicle size distribution of basalt samples collected from the summit and base of Mauna Loa volcano in Hawaii [show] that the technique provides estimates of ambient pressure that provided estimates of elevation with a resolution of about 400 meters."

"We were excited about this," says Sahagian. "There weren't really any good geologic paleoaltimeters to tell you how high a land feature was unless it was at sea level. We could measure water depth better than we could measure elevation.

"But now I had made a paleoaltimeter out of a trivial mathematical formula, and it worked."

...TO COLORADO

Sahagian next took his new technique to the Colorado Plateau, which covers large portions of Utah, Colorado, Arizona and New Mexico. Scientists using different methods to measure the plateau's geologically recent rise in elevation had arrived at seemingly contradictory conclusions as to when—and thus why—the uplift was occurring.

"We tried to settle a dispute between

"WE DID A LOT OF SCOUTING AROUND BEFORE WE FOUND THE RIGHT KIND OF FLOWS," SAHAGIAN SAYS. "WE WANTED TO MAKE SURE THAT THE VESICULARITY WE MEASURED WAS TRULY A FUNCTION OF STRATIGRAPHIC POSITION IN THE FLOW."

those who said this was a recent uplift and those who said it was ancient. It turned out that both groups were right. The plateau has been uplifting for at least 30 million years but it's been uplifting faster in the last five to ten million years than it was before."

...TO MONGOLIA

Most recently, Sahagian has traveled to the Hangay Mountains of central Mongolia to take on another geological puzzle: How did a relatively high region—the Hangay is a plateau with peaks reaching 13,000 feet in elevation—occur in a continental interior where elevations are usually low? Also, the Hangay are located near major rift zones that are stretching and that might be expected to have a flattening effect on the topography.

Sahagian and his collaborator, Alex Proussevitch of the University of New Hampshire and formerly of the Siberian Academy of Sciences in Novosibirsk, Russia, are part of an interdisciplinary team of two dozen researchers that has spent seven years studying the Hangay with a grant from the National Science Foundation. The team includes Lehigh faculty members Peter Zeitler, a geochronologist, Anne Meltzer, a seismologist, and Bruce Idleman, a senior research scientist. The researchers hope to shed light on the geologic history of the Earth and on the connections linking continental deformation, the development of topography and global climate.

In Mongolia, the first order of business for Sahagian and Proussevitch and their colleagues was to search for samples of well-exposed, unaltered lava whose thickness could be accurately measured. As the Hangay Mountains are a region of rugged topography with few roads and little if any infrastructure, the group considered itself fortunate to find a Russian-speaking driver with an all-terrain van.

"We did a lot of scouting around and collected samples," says Sahagian. "We tried to make sure these lava sites had good exposure and that we could see the top and the bottom of a lava flow. We went all over the Hangay Plateau and the surrounding areas, including the Gobi Desert, where there were lava flows as well."

The group collected samples drilling 1-inch-diameter cores. The specimens were dated by Zeitler and his students in Lehigh's Geochronology Lab and found to range in age from 100,000 years to 3-4 million years to 9.5 million years.

"We were fortunate to get a good distribution of ages," says Sahagian.

The researchers next used high-resolution computed x-ray tomography scanning to measure bubble sizes and distributions in the top and bottom layers of each lava specimen. They then determined the ratio of average vesicle sizes between the layers and, subsequently, the atmospheric pressure at the time of emplacement.

"When in doubt," says Sahagian, "go to Hawaii."

The group reported its results last year in an article in the *Journal of Geology*. Its main conclusion: the Hangay Mountains have risen in elevation by approximately 1 kilometer, plus or minus a few hundred meters, in the last 10 million years. When this uplift occurred, and whether it happened all at once, gradually or in fits and starts, has yet to be determined.

Sahagian says that much work remains to be done in the Hangay Mountains.

"This is one of our first results. Many different hypotheses have been suggested as to why the Hangay region is high and why it is uplifting. We're hoping to test these and develop a hypothesis of our own. We're waiting for the results of seismic work that will tell us more about the deep structure of the mantle and upper and lower lithosphere.

"But as far as our basaltic vesicularity work is concerned, our result is robust. One kilometer in 10 million years is not an abnormal rate of uplift. It's very consistent with what others are finding. How do we interpret that result? That's the bigger picture, and it still has to be resolved."

Coordinated Efforts

Chinese firms work with the Chinese government on cultural initiatives that build their legitimacy in the eyes of host governments and societies.

MANAGEMENT

THE QUEST FOR LEGITIMACY

Charles Stevens examines Chinese approaches to investment opportunities in East Africa.

Chinese soap operas, dramas and news translated into Swahili and viewed in East Africa can mean big business, and not only for the entertainment industry. Chinese companies coordinate with the Chinese government on these translations, which, says Charles Stevens, help to gain acceptance—or legitimacy— for Chinese firms in the region.

Companies looking to invest in business enterprises in other countries should be aware of the influence of word-of-mouth associations, traditional and social media and historical legacy when they make their commitments, says Stevens, assistant professor of management.

Chinese firms' efforts to achieve acceptance in East African societies have led to success.

Written by **Amy White**

Photography by **Tim Hetherington**

In a study published in *Global Strategy Journal*, titled "Legitimacy Spillovers and Political Risk: The Case of FDI (Foreign Direct Investment) in the East African Community," Stevens and co-author Aloysius Newenham-Kahindi, associate professor of international business at University of Saskatchewan Edwards School of Business, found evidence of "legitimacy spillovers" in the context of political risk. This is the idea that a firm could face increased challenges or increased opportunities within a host country government or society through no fault or virtue of its own, but simply due to the larger grouping of firms (by country of origin) to which they were perceived to belong.

"Political risk is unforeseen challenges, costs and difficulties due to a political environment," says Stevens. This could come from a government interfering in activities, changing policies or reneging on promises, or from society in the form of rioting, protests, boycotts and terrorism.

"Legitimacy is about whether your activities or presence are viewed as acceptable and appropriate in that particular context," he says. Legitimacy may be granted, officially or unofficially, by governments, general society, media or other stakeholders. It smooths the process of starting and running enterprises and helps decrease impact from unforeseen or negative circumstances.

Stevens and Newenham-Kahindi interviewed expatriates, employees, government officials and other people in communities in five East African countries—Tanzania, Kenya, Burundi, Rwanda and Uganda—to collect information about how foreign companies investing in the regions were viewed and the impacts of those views.

They found Chinese firms had more success than U.S., European or Indian firms, as they engaged in coordinated efforts—such as the translation of television programs and other cultural initiatives, management of political relationships and economic investments with greater scale and scope—that build their legitimacy in the eyes of host governments and societies.

OTHER NEW FINDINGS INCLUDED:

1.) Social media: People in the developing countries studied were very active on social media and mobile phones. "There were lots of conversations about what Chinese, U.S., European and Indian firms were doing (both good and bad) and those conversations quickly spread within the countries and across them."

2.) Long-term commitments: "If the investors are seen as fickle and not caring about the local community, firms' legitimacy can decrease and they'll actually face even more problems."

3.) History: "People often brought up issues relating to colonialism (or a colonial mindset) when discussing foreign firms' activities. It's important for firms to be mindful of the history of the places they're investing in, or else they'll step on 'landmines' they're not aware of."

4.) Cross-country spillovers: "People in Country A really are aware of and talking about what your firm is doing in Country B. This can either make people more positively or negatively disposed toward your firm." For instance, many firms used Tanzania as a stepping stone into other countries in the region. Citizens in these countries would look closely at the experiences that people in Tanzania had with firms from different home countries.

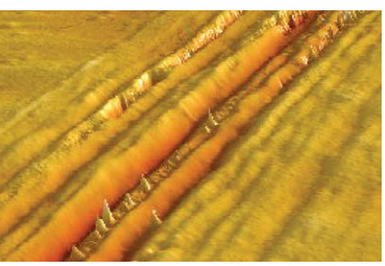
5.) "Lumped together": "People aren't necessarily aware of what each individual firm is doing in their country, but they have strong feelings about 'Chinese firms,' 'American firms,' etc. This can be an opportunity or a threat for firms investing in a country."

Charles Stevens holds the Thomas J. Campbell '80 Professorship. His research interests include global strategy, political risk, legitimacy and stakeholder perceptions, and East Asian business and management issues. He received his Ph.D. from the Ohio State University.

ENGINEERING

A BRILLIANT DISCOVERY

Researchers make a discovery about the ultra-hard mechanical properties of gallium nitride that could impact electronic and digital device technologies.



Gallium nitride (GaN) has emerged as one of the most important and widely used semiconducting materials. Its optoelectronic and mechanical properties make it ideal for a variety of applications, including light-emitting diodes (LEDs), high-temperature transistors, sensors and biocompatible electronic implants in humans.

In 2014, three Japanese scientists won the Nobel Prize in physics for discovering GaN's critical role in generating blue LED light, which is required, in combination with red and green light, to produce white LED light sources.

Now, four Lehigh engineers have reported a previously unknown property for GaN: Its wear resistance approaches that of diamonds and promises to open up applications in touch screens, space vehicles and radio-frequency microelectromechanical systems (RF MEMS), all of which require high-speed, high-vibration technology.

The researchers reported their findings in August in *Applied Physics Letters (APL)* in an article titled "Ultralow wear of gallium nitride." The article's authors are Guosong Zeng, a Ph.D. candidate in mechanical engineering; Nelson Tansu, the Daniel E. '39 and Patricia M. Smith Endowed Chair Professor in the electrical and computer engineering department; Brandon A. Krick, assistant professor of mechanical engineering and mechanics; and Chee-Keong Tan, who received his Ph.D. from Lehigh and is now assistant professor of electrical and computer engineering at Clarkson University.

GaN's electronic and optical properties have been studied extensively for several decades, says Zeng, the lead author of the *APL* article, but virtually no studies have been done of its tribological properties, that is, its resistance to the mechanical wear imposed by reciprocated sliding.

"Our group is the first to investigate the wear performance of GaN," says Zeng. "We have found that its wear rate approaches that of diamonds, the hardest material known."

Wear rate is expressed in negative cubic millimeters of Newton meters (Nm). The rate for chalk, which has virtually no wear resistance, is on the order of 10^{-2} mm^3/Nm, while that of diamonds is between 10^{-9} and 10^{-10}, making diamonds eight orders of magnitude more wear resistant than chalk. The rate for GaN ranges from 10^{-7} to 10^{-9} mm^3/Nm, approaching the wear resistance of diamonds and three to five orders of magnitude more wear resistant than silicon (10^{-4}).

The Lehigh researchers measured the wear rate and friction coefficients of GaN using a custom microtribometer to perform dry sliding wear experiments. They were surprised by the results.

"When performing wear measurements of unknown materials," they wrote in *APL*, "we typically slide for 1,000 cycles, then measure the wear scars; [these] experiments had to be increased to 30,000 reciprocating cycles to be measurable with our optical profilometer.

"The large range in wear rates (about two orders of magnitude) can provide insight into the wear mechanisms of GaN."

That range in wear resistance, the researchers said, is caused by several factors, including environment, crystallographic direction and, especially, humidity.

"The first time we observed the ultralow wear rate of GaN was in winter," says Zeng. "These results could not be replicated in summer, when the material's wear rate increased by two orders of magnitude."

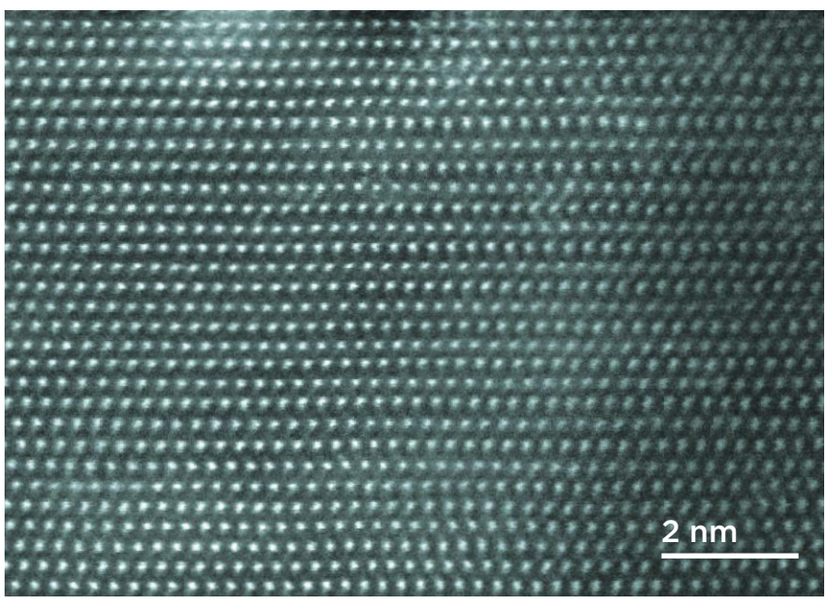
To determine how the higher summer humidity was affecting GaN's wear performance, the researchers put their tribometer in a glove box that can be

(Left) Wear pattern in a sheet of gallium nitride

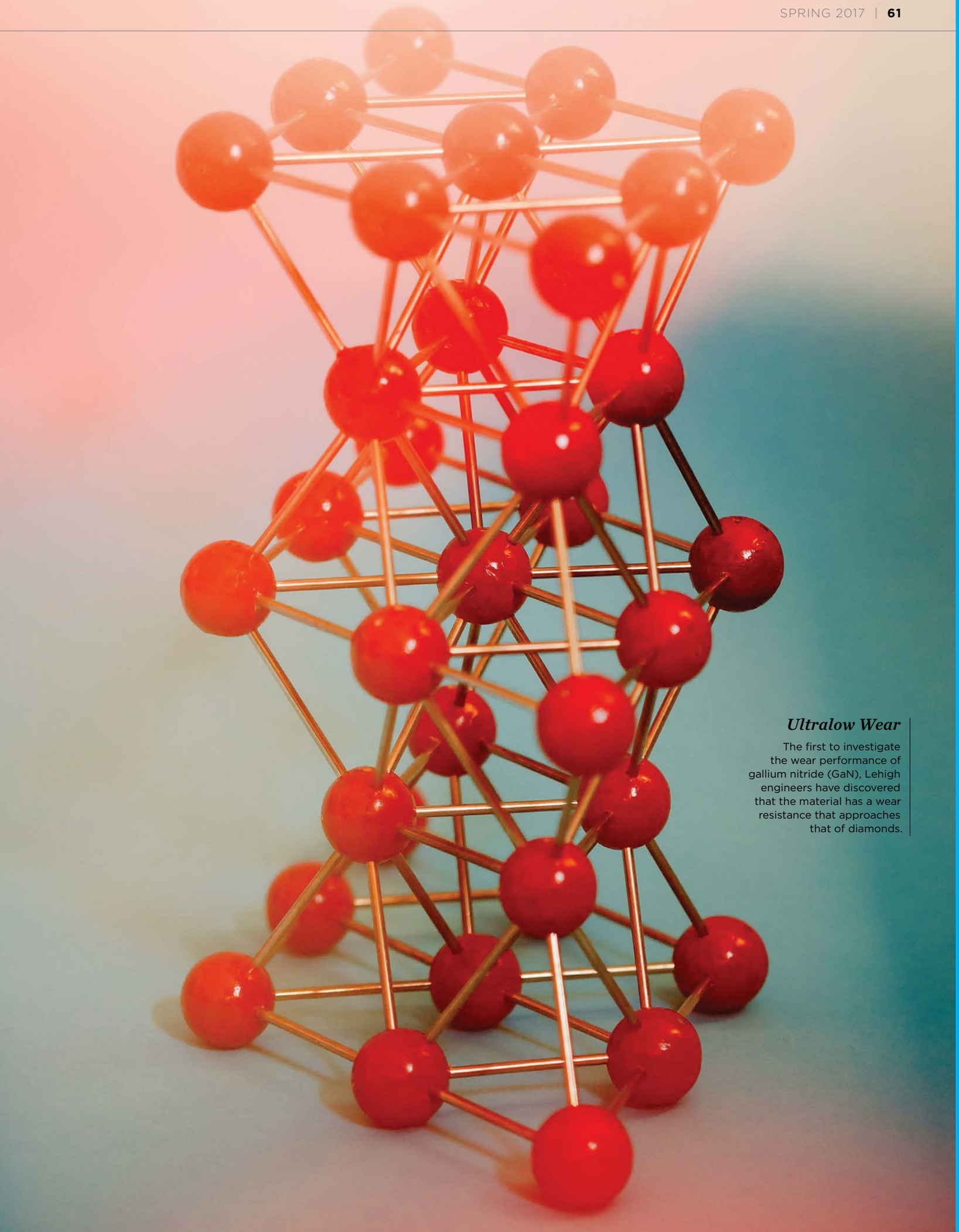
(Below) A magnification of gallium nitride's atomic structure, a hexagonal close-packed crystal lattice

Written by **Kurt Pfitzer**

Photo (right) by **Christa Neu**



Nelson Tansu is the director of the Center for Photonics and Nanoelectronics (CPN) at Lehigh. He has made seminal advances to the invention and innovation, fundamental sciences, and device technologies of III-V and III-Nitride semiconductors. Tansu holds more than 16 patents and is a Fellow of the National Academy of Inventors. He has authored more than 116 refereed journal and 240 conference publications. Tansu received his B.S. and Ph.D. degrees from the University of Wisconsin-Madison.



Ultralow Wear

The first to investigate the wear performance of gallium nitride (GaN), Lehigh engineers have discovered that the material has a wear resistance that approaches that of diamonds.

backfilled with either nitrogen or humid air.

"We observed that as we increased the humidity inside the glove box, we also increased the wear rate of GaN," says Zeng.

Zeng gave a presentation about the Lehigh project last year at the International Workshop on Nitride Semiconductors (IWN 2016) in Orlando, Florida. The session at which he spoke was titled "Wear of Nitride Materials and Properties of GaN-based Structures." Zeng was one of seven presenters at the session and the only one to discuss the wear properties of GaN and other III-Nitride materials.

Tansu, who has studied GaN for more than a decade, and Krick, a tribology expert, became curious about GaN's wear performance several years ago when they discussed their research projects after a Lehigh faculty meeting.

"Nelson asked me if anyone had ever investigated the friction and wear properties of gallium nitride," says Krick, "and I said I didn't know. We checked later and found a wide-open field."

Tansu says the group's discovery of GaN's hardness and wear performance could have a dramatic effect on the electronic and digital device industries. In a device such as a smartphone, he says, the electronic components are housed underneath a protective coating of glass or sapphire. This poses potential compatibility problems, which could be avoided by using GaN.

"The wear resistance of GaN," says Tansu, "gives us the opportunity to replace the multiple layers in a typical semiconductor device with one layer made of a material that has excellent optical and electrical properties and is wear-resistant as well.

"Using GaN, you can build an entire device in one platform without multiple layers of technologies. You can integrate electronics, light sensors and light emitters and still have a mechanically robust device. This will open up a new paradigm for designing devices. And because GaN can be made very thin and still strong, it will accelerate the move to flexible electronics."

In addition to its unexpectedly good wear performance, says Zeng, GaN also has a favorable radiation hardness, which is an important property for the solar cells that power space vehicles. In outer space, these solar cells encounter large quantities of very fine cosmic dust, along with x-rays and gamma rays, and thus require a wear-resistant coating, which in turn needs to be compatible with the cell's electronic circuitry. GaN provides the necessary hardness without introducing compatibility issues with the circuitry.

The Lehigh group has begun collaborating with Bruce E. Koel, a surface chemistry expert and professor of chemical and biological engineering at Princeton University, to gain a better understanding of the interaction of GaN and water under contact. Koel was formerly a chemistry professor and vice president for research and graduate studies at Lehigh.

To determine the evolution of wear with GaN, the group has subjected GaN to stresses by running slide tests in which the slide distance and the corresponding number of cycles are varied. The group then uses an x-ray photoelectron spectrometer (XPS), which can identify the elemental composition of the first 12 nanometers of a surface, to scan the unworn surface of the GaN, the scar created by the slide machine, and the wear particles deposited by the slide machine on either side of the scar.

"NELSON [TANSU] ASKED ME IF ANYONE HAD EVER INVESTIGATED THE FRICTION AND WEAR PROPERTIES OF GALLIUM NITRIDE," SAYS KRICK, "AND I SAID I DIDN'T KNOW. WE CHECKED LATER AND FOUND A WIDE-OPEN FIELD."

The group plans next to use aberration-corrected transmission electron microscopy to examine the lattice of atoms beneath the scar. Meanwhile, they will simulate a test in which the lattice is strained with water in order to observe the variations caused by deforming energy.

"This is a very new experiment," says Zeng. "It will enable us to see dynamic surface chemistry by watching the chemical reaction that results when you apply shear, tensile or compressive pressure to the surface of GaN."

Big Dreams and Perseverance

Nelson Tansu admits that singing, dancing and drawing are not his strong suits. Unfortunately, these skills were required for success as a kindergartner in his native Indonesia. In an educational system in which teachers ranked students, Tansu was ranked 39th of 40 students as a four-year-old boy.

"It definitely did not look like a very promising start for a young boy with a pair of crooked arms," reads *Nelson: The Boy Who Loved to Read*, a children's picture book inspired by Tansu's life story. Fortunately, that low kindergarten ranking didn't hold Tansu back.

Nelson: The Boy Who Loved to Read promotes the importance of having a big dream, having the perseverance to pursue that dream, and obtaining the education to make it possible, Tansu says. Adela Gozali Yose '10G penned the book, which tells the story of a boy who loved to learn, had big dreams and persisted to pursue them.

"It's important to show the struggle that I had as a little kid," says Tansu, who joined the Lehigh faculty at the age of 25. "We tried to ensure that all those weaknesses as a human being are really reflected in this book, so people read it and understand that we all have limitations and that's okay."

The Indonesian version of the book, *Nelson Si Kecil yang Suka Baca*, was selected for the Indonesian International Book Fair in 2015, represented Indonesia in the 2015 Frankfurt Book Fair, and was nominated for the 2017 Asian Children's Book Award. Organizations including the National Library of Indonesia and The United States Agency for International Development (USAID) have distributed copies of the book to children throughout Indonesia to promote its pro-education message.

Brandon Krick leads the Materials Tribology and Surface Interfaces group at Lehigh. His research focus is understanding the fundamental origins of friction and wear. He earned his Ph.D. from the University of Florida.

TEACHING, LEARNING & TECHNOLOGY

EMPOWERING PARENTS

Parents are essential in child language development, says Brook Sawyer. Her work on Parents Plus: Language Coach helps strengthen parents' abilities to help their children.

Sawyer's three-year project is funded with a $1.5 million grant from the Institute of Education Sciences.

Written by **Mary Ellen Alu**

Illustration by **Pep Montserrat**

Many preschool children learn language incidentally—that is, children learn vocabulary, grammar and social patterns of language through listening to parents, siblings and teachers who talk around them.

Not so for children with language impairments. They struggle to learn new words, make conversation or be understood.

"We know that children with language impairments are at significant risk to not have optimal achievement in school," says Brook Sawyer, assistant professor of teaching, learning and technology. "Language impairments are often linked to reading disabilities." But, she says, "If we focus on children at a very young age and support their language development, we optimize their success in school."

To help parents of preschool children with learning impairments learn techniques to improve their children's language skills, Sawyer and fellow researchers are developing Parents Plus: Language Coach, an online resource that will have video and coaching components. Assisted by a speech-language pathologist, parents will learn to use focus stimulation strategies to help their children acquire language.

The three-year project is funded with a $1.5 million grant from the Institute of Education Sciences. Sawyer is working with researchers from Teachers College, Temple University and the Oregon Research Institute to develop the web-based training tool.

"We really want parents to see themselves as having a critical role in their child's language development," says Sawyer. "There's literature that suggests that parents of children with learning impairments may actually start to decrease their language interactions with their children because they don't see those interactions as being effective. They're talking to their children, but they're not getting anything back. It gets discouraging. But if that happens, the child is getting even less language exposure.

"So it's really important to support parents so they know what they can do to help their child. The normal way they might be interacting with their child might not work. You have to be really targeted with what you do, and that's not going to be natural. So we want to give parents some simple tools that they can feel good about using with their child."

Focus stimulation strategies allow parents to interact with their preschoolers in a way that would increase the likelihood they would reach vocabulary or grammar goals. For example, if a child needs to learn the word "green," parents might color with the child and frequently use the word. "I see you're coloring with the green crayon," and "Wow, green makes the grass pretty." Rather than forcing a response, parents pause to give the child an opportunity to respond, whether verbally or another way.

Two advisory boards are assisting with the project—a professional board of teachers and speech/language pathologists; and another of parents. The project is based in the Berks County Intermediate Unit, in Reading, Pennsylvania.

The team plans to begin testing Parents Plus as a feasible option for parents beginning in September 2017. The following year, the project will expand from 16 parents to 30 parents in a randomized control trial, with half using Parents Plus and half not.

"I just see it as so imperative that we give parents some support," Sawyer says.

Brook Sawyer's research aims are interdisciplinary and center on promoting the development of young children who have disabilities or who are dual language learners (DLLs). Her predominant focus is on language and literacy development. She received her Ph.D. from the University of Virginia.

MATERIALS DEVELOPMENT FOR INDUSTRY

TRADITION & TECHNOLOGY

Lehigh's strengths in materials development put the university in a unique position to help shape the future of additive manufacturing.

Lehigh researchers are investigating a variety of less-explored, high-temperature materials for use in additive manufacturing.

Written by **Kelly Hochbein**

From its earliest days, Lehigh has been invested in materials. Mining and metallurgy was one of the university's first academic programs in 1865. It makes sense, then, in an age marked by rapid technological advancements, that Lehigh would turn to materials—in this case, the metals used in additive manufacturing, also known as 3-D printing.

As many universities and research centers explore the applications of 3-D printing, Lehigh is "one of a very small handful of places that has made materials really the focus," says Richard Vinci.

Vinci, professor of materials science and engineering, is director of Lehigh's Center for Advanced Materials and Nanotechnology (CAMN), which fosters fundamental and applied research focused on the development and characterization of materials and processes.

"The center is an interdisciplinary group of researchers from multiple colleges," says Vinci. "[And additive manufacturing] is the kind of technology that benefits from and meets the needs of a diverse set of scholars. It is an area that I think is ripe for an injection of really good materials research."

Last year, Lehigh acquired a Renishaw industrial platform 3-D metal printer, one of only a few 400-watt laser systems Renishaw has installed in the United States. A unique educational partnership with Renishaw allows Lehigh to change the machine's processing parameters as needed for research. Brian Slocum, director of Lehigh's Additive Manufacturing Lab, traveled to England to learn from Renishaw's research and development staff.

The printer employs powder bed fusion technology. Any type of metal that can be rendered in powder form is smoothed, melted with a laser into a single metal piece

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and dropped down 100 microns. A new layer of powder is pushed on top of it and the process repeats, layer by layer.

"The underlying science of that is very similar in many respects to things that have been studied here at Lehigh for decades," says Vinci.

A small number of relatively well understood metals are commonly used in additive manufacturing. Titanium, with its extensive applications in the aerospace and biomedical industries, is among them. But, says Vinci, that small number of materials can't compare to the thousands available to designers working in more conventional machining and fabrication. To better understand and expand the number of materials available for use in additive manufacturing, Lehigh researchers are investigating less-explored metals such as nickel-based materials and is among just a few institutions conducting active research in copper.

Lehigh faculty are working with industry partners—producers as well as end users—to study the use of other high-temperature materials in additive manufacturing.

"Our traditional strengths in understanding how materials behave and being able to look at the structure and chemistry of materials at an atomic level is something that is just beginning to emerge as important to this field," says Vinci. "The time is right for this materials development to happen. That's where I see Lehigh playing in this area and making our mark."

Richard Vinci serves as director of the Mechanical Behavior Lab in the Center for Advanced Materials and Nanotechnology (CAMN). His research is focused on the development and application of techniques for measuring the mechanical behavior of thin films and small-scale structures. He received his B.S. from MIT and his M.S. and Ph.D. from Stanford University.

COMMUNITY HEALTH RESEARCH GROUP

A HEALTHY PARTNERSHIP

In the public health arena, there is a growing recognition that many of the factors that promote, sustain and threaten health operate locally—within individual communities. Lehigh's Community Health Research Group (CHRG) works with members of the local community, nonprofits, healthcare providers, and the public sector to identify and address health needs and health disparities in the Lehigh Valley.

CHRG capitalizes on several of Lehigh's key strengths—a leadership role in a region with significant ethnic and socioeconomic diversity, existing collaborative relationships with community organizations, and interdisciplinary faculty expertise in the health domain. The group adopts the Community-Based Participatory Research (CBPR) approach, in which researchers and community members are equal-status partners in the research process, each contributing their own strengths to gathering and interpreting data and developing interventions.

One current project uses the "photovoice" method to assess health needs from the community perspective, using photographs taken by participants as a springboard for facilitated discussions about health. In another project, the group is partnering with a local Federally Qualified Health Center to evaluate the effectiveness of an innovative opioid addiction treatment program (see page 37).

"ADDRESSING THE HEALTH ISSUES FACING THE LEHIGH VALLEY WILL REQUIRE MANY VOICES AT THE TABLE AND MANY FORMS OF EXPERTISE. LEHIGH'S COMMUNITY HEALTH RESEARCH GROUP PROVIDES A CRUCIAL PIECE OF THE PUZZLE."

–CHRISTOPHER BURKE, FACULTY LEAD

Core Faculty

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Kelly Austin, *assistant professor of sociology*

Christopher Burke, *associate professor of psychology*

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Lucy Napper, *assistant professor of psychology*

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AT LEHIGH, OUR PURPOSE IS TO ENABLE THE NEXT GENERATION TO THRIVE BEYOND THE IMAGINATION OF THE CURRENT. WE APPROACH THE WORLD WITH CURIOSITY, SEEK ANSWERS TO THE MOST CHALLENGING QUESTIONS, AND WORK TO INFORM AND EMPOWER OTHERS. WE LISTEN. WE LEARN. WE IMAGINE. WE SHARE.