AT LEHIGH, WE FOSTER A CULTURE OF DISCOVERY AND CREATIVE EXPRESSION, BUILT ON OUR RECOGNITION THAT NEW UNDERSTANDING AND A SPIRIT OF INQUIRY ARE OUR GREATEST CONTRIBUTIONS TO SOCIETY.
Dedicated to the tradition of research and discovery at Lehigh University, this issue of Lehigh Research Review features a range of articles that highlight the university's commitment to advancing knowledge and fostering innovation. The articles cover topics such as the impact of the JOBS Act, the economics of obesity, moving youth toward success, and more. The issue also includes interviews with researchers and faculty members, as well as updates on the university's research initiatives and programs. 

A TRADITION OF DISCOVERY

During his transformative tenure as Lehigh’s eighth president, Martin Dewey Whitaker made a bold and ultimately crucial decision—one that would shape the future of the university and catapult it into an unprecedented era of discovery.

Whitaker, a world-renowned physicist, believed in the power of new knowledge to change the world for the better, and he believed, too, that if Lehigh was to maintain its position at the forefront of higher education, it needed to vastly expand its research enterprise. With the support of the board of trustees, Whitaker pushed forward on an ambitious plan to do precisely that.

Over the course of his tenure, Whitaker would spend nearly half of the university’s endowment to build new laboratories, hire new faculty, and create new programs to support the brilliant minds that were increasingly calling the university home. By the time he left office in 1960, thanks to his keen vision and the steadfast support of Lehigh’s trustees, the university he led had been completely and utterly changed: It was a bigger, stronger, more intellectually powerful Lehigh.

More than a half-century later, Whitaker’s investment continues to pay impressive dividends—not only for Lehigh, but for the world far beyond South Mountain as well.

Great research—important research—is deeply valued here at Lehigh. We take enormous pride in our ever-expanding efforts to support our faculty in their work because, like Whitaker, we believe in research as an agent of positive social, cultural, political, and economic change.

And we remain committed to fostering an environment in which our researchers are encouraged to take on the greatest of challenges, with the confidence that they can and will deliver the most innovative of solutions while also developing the next generations of researchers through our graduate students.

In the pages that follow, you will read about just some of the exciting scholarship and research that is happening here at Lehigh. From the social and natural sciences to the arts and humanities, from business to civil infrastructure, our faculty is engaged in work that we find fascinating, inspiring—even revolutionary. We have been consistently impressed and often amazed by their work, and we hope you will enjoy reading their stories.

Sincerely,

John Simon
President

Pat Farrell
Provost
The Two Faces of Janus

Anthony Viscardi
Pencil on Mylar
ART & ARCHITECTURE

CASTING AND CAPTURING SHADOWS

Contemporary architectural practice often employs computer-generated algorithms to generate form. Anthony Viscardi engages shadows to do the same by asking the simple question, “If an object can cast a shadow, can a shadow cast an object?”

As a child, Anthony Viscardi tried to hide from his shadow. Today, he seeks them out. As a professor of art and architecture at Lehigh, Viscardi encourages his students to move beyond digital algorithms as they work to create humanly habitable space. He urges them to engage more dynamic processes of natural phenomena that ignite the imagination through observation. A recurrent theme in Viscardi’s pedagogy and professional work as an artist is the phenomenon of light and shadow as the progenitor of form.

When Viscardi arrived at Lehigh in 1992, Ricardo Viera, professor of art and director and curator of Lehigh University Art Galleries, curated a solo exhibition of Viscardi’s shadow work to introduce him to the community. Since that time, Viscardi’s fascination with the shadow has proven to be an inexhaustible premise for inquiry, serving both his academic research and teaching as well as his personal work as an artist.

In speaking of his art, Viscardi says, “In essence, I steal the shadow of the object by tracing its outline, recording its form as it is transformed over time to create a sort of shadow map, from which I construct new objects or drawings.”

For each piece, Viscardi constructs a three-dimensional model and intermittently traces its cast shadow to create a record of the sun’s angular changes throughout one day. The design of the object is transformed over time as the ever-changing shadow directs. He employs a variety of techniques: For some drawings he traces the shadow using pencil on Mylar or ink on watercolor paper; for others, he employs airbrush. When finished, Viscardi discards the generative model—a work of art in and of itself—leaving only captured shadows, a record of how light interacted with an object in a certain place and time. He is currently exploring laser cutters, 3-D printing and CNC (computer numerical control) machines to inform his work.

Viscardi was awarded a coveted MacDowell Colony Fellowship to continue his visual investigations of shadow mapping during his 2011-12 academic sabbatical. The MacDowell Colony is the oldest artists’ colony in the United States and has hosted the likes of Leonard Bernstein, Aaron Copeland and Milton Avery. Talent is the sole criterion for admission. Viscardi’s experience at the MacDowell Colony, he says, helped to define him as a professional artist, independent from his role as an architect/academic.

In 2013, Viera curated Viscardi’s second solo show at Lehigh to exhibit the MacDowell-based work. The Zoellner Gallery exhibition, “Tracing Time to Measure Space,” drew one of the gallery’s highest opening attendances ever.

Viscardi, whose work has been shown at galleries in New York, Philadelphia and numerous European cities, says he prefers not to begin a piece with preconceived ideas. “There is something about the slow act of drawing and making small models that allows your mind to daydream and to meander,” he explains, “and so connections are made, sometimes through mistakes, that aren’t self-conscious or stereotypical.” This is an advantage that modern technology doesn’t always provide, he says.

It takes perseverance and dedication to make great architecture, Viscardi says, and he wants his students to embody that strong ethical stance. The same is true of his art. “If you’re going to make something, let it be meaningful,” he says.

Anthony Viscardi’s art investigates the phenomena of shadow mapping. His work has been exhibited in U.S. and European galleries. Photography by Ryan Hulvat
Like many of Shakespeare’s complex feelings experiences emotional characters, Hamlet ambivalence. It may also make them look weak—and cost them their influence. Indecision, can help leaders make better decisions. The problem? Decisiveness alone is not a good enough reason to choose somebody to be a leader. When we choose that path, we have the potential to miss out on the value of ambivalence.

Management
To Lead or Not to Lead?
Naomi Rothman says emotional ambivalence, often read as indecision, can help leaders make better decisions. The problem? It may also make them look weak—and cost them their influence.

Naomi Rothman grew up in a house filled with conversations about ambivalence. And yet, she says, that was a good thing. Rothman’s father was fascinated by Shakespeare’s plays, and he made it a point to bring his daughter along to as many of The Bard’s plays as possible. Along the way, Rothman, assistant professor of management, says she came to appreciate one of the recurring themes of Shakespeare’s work: The simple but undeniable idea that because much of life is a great deal more complex than we’d like it to be, emotional ambivalence—the state of having mixed feelings or strong but contradictory feelings about something or someone—is not only completely natural, but absolutely inevitable.

“Shakespeare’s plays are infused with ambivalence,” Rothman says. “The relationships in his plays are complicated and nuanced. The reality is, most things in life aren’t as simple as we’d like to think they are, and people often have very complex feelings about situations in their lives and about the people that they love or with whom they work.”

Today, Rothman is using her long-standing interest in the complexity of life—and the ambivalence it often elicits—to try to understand not only how ambivalence helps leaders make better decisions, but also when and why it negatively impacts the way those leaders are perceived. Rothman has explored these dynamics in any number of settings—from politics to business to healthcare. But one recurring theme ties all of the work together: Though emotional ambivalence often serves leaders well when it comes to decision-making, many observers have a hard time accepting that fact.

“I completely understand the need for leaders to be at times decisive, which can help them appear strong and powerful in the face of competitors or in times of conflict,” she says. “But we have to understand that there is also a time and place for experimenting and even expressing contradictory states such as ambivalent emotions.”

Rothman helped uncover the surprising importance of ambivalence in a 2013 paper, co-authored with colleagues from the University of Michigan. She found that when individuals felt emotional ambivalence (both happy and sad) about a certain problem or situation, they were more likely to be open to alternative perspectives relative to when they felt happy or sad alone. This was important, because as the study revealed, forming a judgment based on multiple, diverse perspectives helped the ambivalent individuals reduce errors in subsequent forecasting decisions. The authors went so far as to say that emotional ambivalence can help people to see the world in new ways and could even expand their overall cognitive abilities.

“We have learned that when individuals feel mixed emotions about a decision, this leads them to seek diverse perspectives and to even gather pieces of information that may conflict with each other,” she says. “This openness to diverse perspectives actually allows individuals to make better decisions presumably because, when combined, the errors within those different pieces of information can be canceled out.”

The value of mixed emotions, then, is clear. The problem, Rothman says, is that those benefits must be weighed against the fact that, according to her other research, there are a number of situations in which many people simply don’t believe leaders should be ambivalent about anything, and so leaders are penalized for showing their ambivalence in those contexts. In a series of studies conducted over the past three years, Rothman has found that when individuals outwardly express ambivalence, they are more likely to be viewed as submissive, indecisive or even incompetent. In a competing context, this could open up ambivalent leaders to more aggressive tactics from rivals, while in other contexts—politics, for instance—it can create the perception that they are not fit to lead. To put it simply, ambivalence hinders their influence—even though it really shouldn’t.

Rothman hopes her work can help drive people to overcome this inherent bias and reconsider what it is they really want in their leaders, as well as inspire managers to use ambivalence as an influence tactic effectively, such as after establishing cooperative norms for engagement.
AN ECOFEMINIST PERSPECTIVE ON HEALTH

Climate change is the biggest global health threat of the 21st century, according to the 2015 UCL-Lancet Commission on Health and Climate Change. Kelly Austin examines its impact on women’s health.

When environments are degraded and forests are cut down, people are forced to plow harder, walk longer to find firewood and water, and dig deeper wells. The added physical strain of this work impacts their health, and severe hunger and a lack of clean water affect their ability to stave off infection.

In less-developed nations, says Kelly Austin, those overworked individuals are primarily women.

In places like Latin America, Africa and Southeast Asia, men are more likely to be engaged in the formal market, says Austin, assistant professor of sociology. Gender dynamics lend women to be the liaisons who turn environmental resources into usable household goods.

Women plow the fields, grow the food and search for water. Additional time spent on these tasks prevents women from pursuing educational and economic opportunities that might improve their status and therefore have a positive impact on their health.

Austin’s research examines the intersection of the environment and health—how changing environmental conditions impact the physical well-being of those living in poor nations. She recently co-authored a paper in the professional journal Social Problems. The paper, “Ecological Losses are Harming Women: A Structural Analysis of Female HIV Prevalence and Life Expectancy in Less-Developed Countries,” links environmental degradation to the health of women in poor nations.

Informed by ecofeminist perspectives, which link women’s well-being to environmental well-being, the study analyzed the direct and indirect effects of ecological losses on female health outcomes in a structural equation model of 136 less-developed nations. Austin and her co-author, Laura McKinney of Tulane University, found that ecological losses are tied to female HIV and reductions in women’s longevity via increased HIV rates, hunger and diminished health resources.

Austin and McKinney claim, is likely cyclical and intergenerational, “in ways that sewn together and compounded the smile experienced by each successive generation.” Developmental and epidemiological approaches to improving women’s health may benefit from including environmental dimensions as a key area of concern.

Austin hopes that her research might draw attention to women as essential participants in the global conversation about climate change.

“A phrase I hear a lot in my work in Uganda is, ‘It’s women who work the land, but men who own it,’” says Austin. “If we really want to think about stewardship of the environment and how we’re going to mitigate the effects of climate change, it’s really women who should be leading the discussion.”

Further Examination

Austin plans to take her examination of environmental degradation and women’s health even further with two more studies. One, currently under review, examines how, in societies where women have better socioeconomic standing or more decision-making power, there is less death, illness, hunger and displacement from climate-related disasters.

Austin found that women tend to rechannel power into provisions for sanitation systems, schools and other infrastructure that help to mitigate a natural disaster’s impact on the population.

“I don’t stop the flood or hurricane from occurring... but if you have an improved sanitation system, the chance of it leading to a cholera outbreak is much less in the wake of a flood than if you just have a pit latrine,” says Austin.

In a third study, Austin and her colleague will look at how being impacted by climate disasters relates to female HIV, bringing their examination of HIV, women and environmental change full circle.
A sophisticated software program helps narrow down the 3 to 5 million stars observed over the whole survey to roughly 5,000 that bear further scrutiny. When enough data has been gathered that can be attributed to transiting planets, the most likely exoplanet candidates are selected, and members of a secondary cohort of researchers perform their own observations and analyses. The ability to confirm an exoplanet's existence hinges on the precision measurement of its host star's brightness. The typical operation of the KELT scopes involves observing a single star several times a night for about five years. In the process, astronomers gather at least 8,000 brightness data points. A complete graph reveals a line representing that star's brightness profile, including any periodic dips in brightness. Once exoplanet status has been determined, astronomers can use the host star's change in brightness, or transit depth, to calculate several figures that paint a fuller portrait of the planet. They can measure its radius and the extent of its atmosphere. The gravitational wobble the planet causes in the star helps them figure out the planet's mass and then the density. Using transmission spectroscopy to examine the transit depth leads to information about the atmospheric composition. How many of the 3,984 planets found so far by KELT and other telescopes could be habitable? The answer is probably still far in the future, Pepper says. For now, astronomers are still trying to decide what defines an Earth-like planet.

**Astrophysicist and assistant professor of physics Joshua Pepper has been chasing exoplanets since his graduate school years at Ohio State University. While studying a black hole problem, he helped formulate a plan for a NASA mission to find exoplanets using the transit method, which examines an apparent periodic dimness in a star due to a planet passing in front of it. Pepper realized that he could design and build a telescope dedicated to finding exoplanets. Pepper's initial project has evolved into the Kilodegree Extremely Little Telescope (KELT) survey. It uses two robotic programmable telescopes, one in Arizona and the other in South Africa. The survey has confirmed 15 exoplanets using the transit method. Lehigh, Vanderbilt University and Ohio State run the KELT project together, and the project's low-resolution telescopes are dwarfed by other telescopes that have 18-meter apertures in order to stare at tiny sections of the sky at high resolution. The wide-angle KELT view of the universe, by contrast, comes from a mere 4.5-centimeter aperture with a high-quality digital camera and lens assembly that captures the light of 100,000 stars with each exposure.

"The goal of KELT is to discover more planets that are orbiting the brightest stars we can see. In essence, those give us the very rare, very valuable planets," Pepper says. Planets orbiting bright stars are easier to characterize with follow-up observations that provide more information about mass, size, density, orbit, radiation patterns and atmospheric composition. A sophisticated software program helps narrow down the 3 to 5 million stars observed over the whole survey to roughly 5,000 that bear further scrutiny. When enough data has been gathered that can be attributed to transiting planets, the most likely exoplanet candidates are selected, and members of a secondary cohort of researchers perform their own observations and analyses. The ability to confirm an exoplanet's existence hinges on the precise measurement of its host star's brightness. The typical operation of the KELT scopes involves observing a single star several times a night for about five years. In the process, astronomers gather at least 8,000 brightness data points. A complete graph reveals a line representing that star's brightness profile, including any periodic dips in brightness. Once exoplanet status has been determined, astronomers can use the host star's change in brightness, or transit depth, to calculate several figures that paint a fuller portrait of the planet. They can measure its radius and the extent of its atmosphere. The gravitational wobble the planet causes in the star helps them figure out the planet's mass and then the density. Using transmission spectroscopy to examine the transit depth leads to information about the atmospheric composition. How many of the 3,984 planets found so far by KELT and other telescopes could be habitable? The answer is probably still far in the future, Pepper says. For now, astronomers are still trying to decide what defines an Earth-like planet.

"The first KELT discovery, KELT-1b—a brown dwarf located in the constellation Andromeda—is too cool to be a star and too hot to be a planet. Fewer than a dozen brown dwarfs have been found that transit a star, and KELT-1b has the brightest host star of any transiting brown dwarf ever found. A bit larger than Jupiter in size, it is nevertheless about 30 times Jupiter's mass, making it a highly unusual specimen. "Clearly, this brown dwarf doesn't fit the theoretical models, so the models need to be adjusted. That's a game changer," Pepper says. Astronomers theorize that KELT-1b's inflated size is due to extremely intense radiation from its host star.

Pepper is now looking for targets for the upcoming NASA Transiting Exoplanet Survey Satellite (TESS), slated to launch in 2017. TESS will survey the entire sky for 200,000 of the brightest stars, in the hope of finding small, rocky planets. In the first two years, the orbiting telescope will sweep 90 percent of the sky and continue until it has covered the entire sky visible from anywhere around Earth. "There are still a ton of questions out there. We're still trying to figure out if other solar systems are like ours, if planets like the Earth are common or not," Pepper says. "The potential of this line of research is absolutely enormous."

**Joshua Pepper** received his Ph.D. from Ohio State University and completed his postdoctoral studies at Vanderbilt University. His research involves the discovery of exoplanet s with particular focus on the KELT project.
A NEW VISION FOR GLASS

A personal challenge from a respected colleague set Himanshu Jain in search of ways to put glass to use in important and innovative applications. His work has placed the material at the forefront of the budding field of biomedicine.

Himanshu Jain has a knack for engaging in conversations with just the right people at just the right time. In 2004, a casual chat with the person sitting next to him at a banquet in Cairo, Egypt, ended up guiding much of his research over the next decade. The result—thanks in part to additional fortuitous hobnobbing later—has been groundbreaking advances in a significant area of biomedical materials research.

Jain, the T.L. Diamond Distinguished Chair in Engineering and Applied Science and professor of materials science and engineering, had his momentous conversation at a workshop with colleagues from the United States and Africa. Seated next to him was Mona Marei, who headed the tissue-engineering lab at Alexandria University’s Faculty of Dentistry. “We started chatting, and when I said I worked on glass, she said, ‘You guys are no good,’” Jain says. “I was kind of taken aback. I said, ‘Tell me why you think that way.’”

Marei had been using implanted biocompatible glass to repair deteriorated or damaged teeth and bone but wasn’t happy with her results. After the Cairo workshop, Jain visited Marei’s lab to learn more. “I had no serious understanding of the human body, let alone bone,” he says. “But I found the whole idea of tissue engineering intellectually very exciting.”

Jain had decades of experience developing sophisticated forms of glass for biomedical sensors, communications and microelectronics. In 2004—with funding from the National Science Foundation—he helped establish the International Materials Institute for New Functionality in Glass at Lehigh. The Cairo workshop was an introductory event for NSF International Materials Institute participants. NSF was seeking to promote international research collaborations. Jain wanted to revitalize glass research and education, which was declining nationally due to glass’s energy-intensive costs and to global competition. “I didn’t want to see glass in this country go the way of steel,” Jain says. “We needed more value-added glass products that require research and innovation.”

RICH IN PORES

For hundreds of years, scientists had sought to make glass that lasts. “Like with windows,” Jain says. “They last for centuries.” Marei’s challenge—and a key to future medical applications—was to create a biomedically active glass that goes away after it has served its purpose. That purpose was to provide a “scaffold” that would help the body regenerate its own bone. It differs from conventional body part replacements, especially of hard tissues, which usually rely on long-lasting synthetic implants. “The body doesn’t regenerate most organs by itself,” Jain says. “But if you provide the right kind of microenvironment, it can.”

Researchers had already established that glass can be made biocompatible, meaning the body will accept it and not reject it. Jain took it a step further. In 2006, he and his team created bioceramic glasses for tissue engineering applications that are absorbed once the defect has been repaired. "We call it ‘surgical glass’—glass that is surgically implanted but can be absorbed just like an intravenous saline solution," Jain says. "The body doesn’t reject it, but it also doesn’t make bone from it.”

Researchers have also demonstrated that the glass can be tailored to promote bone growth. "It’s like engineering a microenvironment," Jain says. "You’re changing the chemistry, the porosity and the other properties of the glass to get the reaction you want."
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 biodegradation and to foster its ability to regenerate bone, which is naturally porous.

The difference is that a grain of sugar has a proportionally much larger surface—the height and width of the grain is 10,000 times smaller than macro-pores would also allow space inside the scaffolding material to have a composite of glass and pores.

As with his initial conversation with Marei, Jain had another proponent to his vision. "When I first met Dr. Marei, I thought we had a solution," Jain says.

"IF AN ENGINEER CAN DESIGN A MATERIAL THAT CAN GO INTO THE BODY, HAVE CELLS BIND TO IT, REGENERATE NATURAL MATERIAL AND THEN DEGRADATE—THAT’S AMAZING."
Lee Kern works with a team of researchers to learn how to best help students experiencing mental health and behavioral disorders.

High-school students experiencing severe mental health and behavioral disorders often drop out of school, have trouble getting jobs or wind up in jail, says Lee Kern, professor of special education. How best to intervene so that students’ problems can be minimized? That question was central to a large, five-year study led by Kern and conducted by researchers at Lehigh and six other institutions—Ohio University, the University of Missouri, the University of South Carolina, the University of Kansas, the University of Houston (TIMES) and Miami University of Ohio. With more than $10 million in funding from the U.S. Department of Education, they established the Center for Adolescent Research in Schools (CARS), working with more than 600 students at 54 high schools. Twelve of the schools were in Pennsylvania’s Lehigh Valley and the surrounding region.

"Older students with emotional and behavioral problems have long been neglected," Kern says. "Very little research is conducted with this age group, so we lack information about effective interventions. Teachers are reluctant to provide supports because they expect adolescents to be independent. And the nature of most high schools—in which students have multiple teachers, none of whom usually gets to know them well—makes identification and service delivery difficult."

The CARS team developed and evaluated a range of interventions, including mentoring, to help reduce the difficulties that students with severe mental health and behavior disorders experience. They also developed a model for delivering services. The study provided a rich data pool, allowing researchers to not only assess the effectiveness of various interventions but also the kinds of mental health services that students received, where and at what age they received them, and the link between the severity of their problems and the types of services provided. They’re looking at whether interventions failed because they weren’t implemented as designed and whether students’ ethnicities, family incomes and school locations figure into who gets services.

"We’re looking at the outcomes different ways," Kern says. Of great concern to the researchers, based on the findings, was that students with severe mental health and behavioral disorders weren’t always getting the services they needed, such as interventions and classroom supports.

In launching the project, researchers asked school officials to refer students with the most intensive social, emotional and behavioral problems; they did not specify whether the students should be diagnosed as in need of special education. As a result, Kern says, about half of the students in the study had a special education diagnosis and half did not.

Except for lower academic performances among students with learning disabilities, researchers found that on every standardized measure there were no differences between those who had received special education diagnoses and those who had not.

"So if we’re talking about depression, we have kids who are significantly depressed who are identified as having emotional and behavioral disorders, and they’re guaranteed services by the school," Kern says. "We have another group of students, which is probably just as many, who are depressed but not guaranteed any kinds of services because they’re not identified as having behavioral disorders."

Kern says the researchers see a need to screen all high-schoolers for social, emotional and behavioral problems because schools, through their special education identification systems, are just not picking up all the adolescents with significant needs.

Lee Kern’s research interests include emotional and behavioral disorders, positive behavior support, school-based interventions and attention-deficit/hyperactivity disorder (ADHD). She received her Ph.D. from the University of South Florida.
If schools don’t provide interventions, she says, “it’s unlikely kids will get any kind of services for their mental health needs. Very few kids get community services. And when they do, they usually go once or twice, so they’re not getting a sufficient dosage to really make a difference.” Such services need to be expensive to administer, especially when looking at cost-benefit ratio, she says. Most interventions can be group-delivered, providing effective ways to reduce students’ anxiety and depression. “It’s just that schools don’t think they’re responsible for providing them,” Kern says. “Whether that’s right or not, we know that if they don’t provide them, students are not going to get them.”

Schools also can reduce the stigma associated with mental health services by making programs available schoolwide, she says. Using a mapping process, the researchers also found that school resources were not being used effectively. “For example, school staff spent a lot of time responding to crises, rather than putting preventative interventions in place,” she says. “Also, trained school staff, including counselors, spent a lot of time on tasks such as scheduling that do not equate on their skills.” Among interventions, a Check & Connect mentoring program proved valuable, regardless if students were paired with someone of the same gender and ethnicity. “That’s a positive finding, that it doesn’t matter who your mentor is,” Kern says. “Just the mentoring process itself is really helpful to these students.”

It’s important for practical reasons too, since it’s sometimes difficult to find mentors in the schools who match students in race and gender. In the project, mentors were mostly teachers, but also coaches and administrators who met with the students once a week and talked about schools and future plans, and sometimes, family and friendships. Mentors also reviewed dropout indicators such as grades, absences and tardiness. Both administrators who met with the students and mentors rated the relationship very highly.

Among interventions, the researchers have made recommendations to the U.S. Department of Education to consider whether there needs to be more focus on the troubled students tend to focus on reducing emotional and behavioral problems reported being less satisfied than high school boys with their families, themselves and life in general. Whether that’s due to differences in development, gender expectations or the availability of interventions, the researchers see a need to carefully examine the appropriateness and effectiveness of interventions for adolescent girls.

Given the students’ high dropout rates and poor school outcomes, researchers were not surprised to find that students with severe emotional and behavioral problems were unhappy at school. However, interventions that can increase students’ satisfaction with school are important, the data suggests. It’s likely, researchers said, that students who feel better about school will do better academically and stay enrolled. The CARES team also found that high school girls with severe emotional and behavioral problems were unhappy at school. However, interventions that can increase students’ satisfaction with school are important, the data suggests. It’s likely, researchers said, that students who feel better about school will do better academically and stay enrolled.

The CARES team also found that high school girls with severe emotional and behavioral problems reported being less satisfied than high school boys with their families, themselves and life in general. Whether that’s due to differences in development, gender expectations or the availability of interventions, the researchers see a need to carefully examine the appropriateness and effectiveness of interventions for adolescent girls.

Latinos students also were found to be significantly less satisfied than black students with their lives, but further study is needed. Findings have so far been published in the *Journal of Emotional and Behavioral Disorders*, *School Psychology Review*, *Journal of Clinical Child and Adolescent Psychology*, *Journal of Behavioral Education* and *Review of Educational Research*. More papers are pending.

The researchers have made recommendations to the U.S. Department of Education, including the possibility of funding schools that can be models for educators. “Once we find schools that are doing good things, [we should] support them in doing those things, collect the data that they aren’t able to collect, show that they have good outcomes and then those schools are much more visible,” Kern says. “People can see, this is how you do it, this is the structure, this is how you allocate resources.”

MATERIALS SCIENCE

**UNCHARTED TERRITORY**

**Martin Harmer’s research could fundamentally transform basic understanding of thermal processes, leading to revolutionary advances in the performance and applications of materials.**

Martin Harmer’s research seeks to understand a phenomenon about which very little is currently known: atoms that behave in a manner contrary to nature. Harmer’s work has the potential to revolutionize scientists’ basic understanding of thermal processes and inform the development of new materials that could withstand higher temperatures. A breakthrough in this area could lead to significant increases in engine efficiency, for example, saving billions of dollars in fuel costs. The W.M. Keck Foundation, known for funding science and engineering projects with the potential to pioneer new territory in a field, has awarded Harmer a $1 million grant to discover and understand the unknown atomic mechanisms associated with anti-thermal behavior. They will then use this understanding to design new materials with enhanced thermal performance that have the ability, for example, to increase the operating temperature and efficiency of engines, or the service life of bulk nanoscale solids. With this funding, Harmer and his colleagues will apply a novel method for measuring anti-thermal behavior to millions of materials. The team will seek to understand the process by applying methods of atomistic simulation and velocity microscopes. The team will use these tools to image the atomic movements associated with anti-thermal behavior. An imaging stage will be utilized to image the movements of individual atoms. The researchers will then use this data to model the temperature and efficiency of engines, or the service life of bulk nanoscale solids.

Martin Harmer says, “This project will allow us to explore uncharted territory that could potentially uncover the secrets of nature’s counterintuitive thermal behavior and pioneer new approaches to materials science.”
ECONOMICS

THE ECONOMICS OF OBESITY

With obesity rates on the rise, Chad Meyerhoefer examines the medical costs of a nationwide epidemic and how the U.S. might address it.

Obesity rates have more than doubled in the U.S. in the past 30 years. A significant risk factor for diabetes, cardiovascular disease and other clinically significant health problems, obesity accounts for almost 21 percent of U.S. healthcare costs. Chad Meyerhoefer, associate professor of economics, and a team of researchers have added new understanding to the obesity epidemic and its costs.

Quantifying how much obesity increases medical costs is difficult. Previous obesity studies were skewed because they failed to account for poverty and erroneous reporting, Meyerhoefer says. Obesity rates are higher among low-income populations, who tend to have less access to healthcare, for instance.

“If you don’t address those issues, then you’re going to significantly underestimate the cost,” Meyerhoefer says.

Meyerhoefer and his colleagues—Lehigh doctoral student Adam Biener, John Cawley of Cornell University, and Mette Hammer of Cornell University, and Neil Wintfeld of Novo Nordisk, Inc.—developed a methodology to correct existing models for those two factors using data from the Medical Expenditure Panel Survey (2010–2012). They studied data involving adults with and without diabetes.

The team found that the greatest savings in medical costs occurred when morbidly obese individuals with diabetes lost between 5 and 10 percent of their body mass index. Surprisingly, when the researchers compared medical costs associated with men who were in the low end of the obese range with men who were of normal weight, there was essentially no increase in cost, Meyerhoefer says.

Instead, the researchers found a nonlinear relationship between weight gain and medical costs.

“We thought we’d see an elevation in cost as people became overweight. You don’t see that. Costs don’t go up until you get into extreme obesity,” he says.

The study found that a relatively small percent of the population, those with the highest BMI and classified as having class 3 obesity, generate most of the medical costs of obesity. Meyerhoefer and his team also found that the medical costs of obesity in the United States are much higher—nearly $316 billion a year—than previous studies had shown.

To put it in perspective, that’s about the annual cost of Parts A and B of the Medicare program combined. In addition, the study found the average cost to treat obese individuals has risen 14 percent since 2005.

Meyerhoefer says the study can be used by researchers, policy makers, health insurers, employers and government agencies to calculate the cost-effectiveness of interventions to prevent and treat obesity.

By encouraging employees to avoid weight gain, for example, companies can save money and write off some of the costs by implementing a workplace weight loss program through subsidies provided through the Affordable Care Act.

“The study, “Savings in Medical Expenditures Associated with Reductions in Body Mass Index Among U.S. Adults with Obesity by Diabetes Status,” was published in the journal *PharmacoEconomics* in 2014. Along with another study in the *Journal of Health Economics*, it has become one of the most cited on the topic. The American Heart Association and the Institute of Medicine are among those who have adopted the findings.

Key Findings

- The average inflation-adjusted annual medical care costs of adult obesity in the United States rose from $3,070 in 2005 to $3,508 in 2010—an increase of 14.2 percent.
- Adult obesity raises annual medical care costs in the U.S. by $316 billion (2010).
- Individuals with a BMI of 35 or greater (moderate risk or class 3 obesity) have medical care costs 34 percent higher—nearly $316 billion a year—than previous studies had shown.
- The estimated savings in annual medical care costs from a 5 percent reduction in weight is $2,137 for those with a starting BMI of 40, $1,290 for those with a starting BMI of 35, and $69 for those with a starting BMI of 30.
- The medical care costs for individuals with diabetes are greater than for those without diabetes at every unit of BMI, and at high levels of BMI, this difference amounts to thousands of dollars per year.
- The estimated savings in annual obesity-related medical care costs from a 5 percent reduction in weight is $2,137 for those with a starting BMI of 40, $1,290 for those with a starting BMI of 35, and $69 for those with a starting BMI of 30.
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Chad Meyerhoefer’s research interests include the economics of health and nutrition, and much of his work involves the use of microeconometric methods to evaluate and inform public policy. He received his Ph.D. from Cornell University.

*Novo Nordisk provided financial support for the study.*
The treatments for cancer, says Damien Thévenin, can sometimes seem worse than the disease itself. Patients undergoing chemotherapy, he notes, suffer nausea, fatigue, loss of bone marrow and other side effects as the “chemo” kills good cells and bad alike.

Other therapies seek to target and kill cancer cells by employing antibodies that “recognize” receptors on the membrane of cancer cells and release drugs only inside those cells. But cancer cell membrane receptors come in many varieties, says Thévenin. Cancer cells from different tumors have different receptors, and even cancer cells in the same tumor can also have different receptors.

“You have to know the kind of cancer a patient has and fit the targeting strategy to the cancer,” says Thévenin, assistant professor of chemistry. “This requires a biopsy, a genomic analysis and drug targeting that is very specific to the type of cancer. All of this is labor-intensive and very expensive. In addition, while this strategy can be successful, it only works against very specific types of cancers.”

In the past two decades, Thévenin and other scientists have turned their attention to pH. The extracellular environments of almost all cancers, Thévenin says, have a lower pH than the environments of healthy cells, making them more acidic and giving cancer drugs a broader, more general target to aim at.

Thévenin and his students are developing a unique targeting and delivery system that uses a peptide, or amino acid chain, to seek and destroy cancer cells. The peptide, called pHLIP for pH (Low) Insertion Peptide, is one of the transmembrane domains of a protein called bacteriorhodopsin, which is sensitive to light and is found in highly salty water. (pHLIP is pronounced like the word flip.)

In lab tests, pHLIP has shown the ability to deliver a potent anti-cancer drug to cancer sites based on their low pH and to release the drug in cancer and breast tumor cells. The drug is the FDA-approved Monomethyl Auristatin E (MMAE). The project has been funded by a grant from the National Institutes of Health/National Cancer Institute.

In an article published in 2015 in Molecular Pharmaceutics, a journal of the American Chemical Society, Thévenin’s group reported that a conjugate, or pairing, of pHLIP and an auristatin anti-cancer drug inhibited more than 90 percent of cancer cell growth in two hours of incubation.

“These results,” the group wrote, “indicate that pHLIP-based auristatin conjugates may have an enhanced therapeutic window as compared to that of free drug providing a targeting mechanism to attenuate systemic toxicity.”

The article by Thévenin’s group, titled “Inhibition of Cancer Cell Proliferation and Breast Tumor Targeting of pHLIP-Monomethyl Auristatin E Conjugates,” was authored by Kelly E. Burns, a Ph.D. candidate in chemistry; Matthew K. Robinson of the Fox Chase Cancer Center in Philadelphia; and Thévenin.

**FOUR CRITICAL OBJECTIVES**

To be effective, says Thévenin, drug targeting and delivery systems should meet four objectives:

1. The targeting system—in this case, pHLIP—must be able to locate cancer cells and spare healthy ones.

2. It must be able to deliver, or translocate, the drug into the targeted cell.

3. The drug attached to the targeting device must be delivered only to cancer cells and avoid harming healthy cells.

4. The drug should be relatively cell-impermeable, meaning it will not escape, or diffuse out of, the cancer cell after it has been infused into it.

The pHLIP-MMAE conjugates, says Thévenin, meet all four objectives:

First, pHLIP has demonstrated the ability to target tumors in mice based on the relative acidity of their environments.

Second, the pH at which pHLIP folds...
and translocates MMAE into cancer cells corresponds to the pH of tumor environments. During translocation, the drug is released directly into the cell cytoplasm without requiring interactions with cell surface receptors or the formation of pores in cell membranes.

Third, pHILP is capable of delivering into cells an array of molecules and peptides that would not be able to cross the cell membrane on their own. “We have treated different types of cultured cells in vitro, including triple-negative breast cancer cells, with different amounts of pHILP–MMAE at different pH levels,” says Thévenin. “The pHILP–MMAE conjugates exhibit between an 11- and 144-fold higher antiproliferative effect at low pH than that at physiological pH and a pronounced pH-dependent cytotoxicity as compared to that of free drug.”

In their paper, Thévenin’s group reported that the pHILP–MMAE conjugates “induce a potent cytotoxic [cell destruction] effect (more than 50 percent inhibition of cell growth) in a concentration- and pH-dependent manner after only two hours incubation without any apparent disruption of the plasma membrane.

“We are also the first group to show in mice that a pHILP–drug conjugate is still going to the tumor site as expected. We have discovered that the cytotoxicity [cell destruction] depends on the pH and on the drug concentration.”

PLANS FOR THE FUTURE

Thévenin has been studying pHILP since 2006, when he joined the lab of Donald M. Engelman, a Yale biophysicist, as a postdoctoral researcher. Engelman had previously discovered that pHILP changes shape at a low pH and that this property previously discovered that pHLIP changes down tumor progression, but also prolongs survival of treated mice.

In Engelman’s lab, Thévenin successfully demonstrated that pHILP could deliver cell-impermeable drug molecules through cell membranes.

Today, Thévenin’s group makes pHILP. In the lab. To do so, Burns links amino acids to each other using a process called solid-phase peptide synthesis and then joins MMAE and pHILP with a disulfide bond. She is currently synthesizing MMAE in a process that requires 19 steps. Thévenin’s group collaborates with researchers at the Fox Chase Cancer Center, who conduct in vitro experiments. Together, they recently showed that a pHILP conjugate with an auristatin drug more potent than MMAE not only slows down tumor progression, but also prolongs survival of treated mice as compared to non-treated mice.

Thévenin has two other research projects that are related to cell membrane proteins and biophysics. In one, which is also funded by the National Cancer Institute, he seeks to understand how a specific family of membrane proteins (the receptor tyrosine kinases) assemble and influence cell signaling. In another, he is developing backscattering interferometry to study membrane proteins.

The pHILP project has also been supported by a Faculty Innovation Grant (FIG) that Thévenin received with Marcos Pires, a chemistry professor at UC San Diego. The FIG aims to give graduate students more freedom to pursue their projects with more money.

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When President Barack Obama signed the Jumpstart Our Business Startups (JOBS) Act into law in 2012, many in politics and business believed it would help American startups soar.

The bill contained provisions intended to make it easier for small and growing companies to go public, help them raise capital and ease their transition from young firms to budding business powerhouses. As written, the law provided young companies with important reporting exemptions with the SEC, gave them a pass on some of the more restrictive obligations of the Sarbanes-Oxley Act and more.

At a time of increasingly bitter partisanship in Washington, the JOBS Act was a true rarity—a bill supported by both Republicans and Democrats. When it became law, Obama called the bill a “game-changer” for the American economy, while Eric Cantor, then House Majority Leader, said it would allow business owners to “take risks, grow and create jobs.”

With such broad-based support, the JOBS Act seemed all but certain to succeed. But nearly three years after the bill’s passage, Kathleen Hanley, the Bolton-Peella Endowed Chair in Finance, began to wonder about its actual impact—and set out to determine whether it had succeeded as its backers claimed it would.

Hanley teamed with colleagues at the University of Virginia and Tulane University to perform an in-depth study of 312 initial public offerings (IPOs) for so-called Early-Growth Companies (EGCs) issued between April 2012 and April 2015. They sought to determine whether Title I of the Act was effective in reducing the measurable costs of going public.

Although the JOBS Act promised to help reduce the initial and ongoing costs of being a public company, Hanley and her colleagues found “no evidence” that the bill reduced the direct costs of an IPO—typically, expenses tied to accounting, legal and underwriting fees. Additionally, the team discovered an unintended consequence for companies that choose to pursue an IPO under the protections of an EGC, specifically, the IPOs they studied seemed to suffer “significantly” higher rates of underpricing, a trend they believe is tied directly to the legislation’s more lax rules for transparency. “Overall, our results are consistent with a large body of literature that shows that investors value transparency,” Hanley wrote. “In its absence, issuers are penalized by lower prices for their securities,” the team wrote.

Even so, the team says there is still hope for the bill. Despite the financial difficulties the EGC status conveys, the team was surprised to see that most companies eligible for those protections continue to adopt them—a sign that those companies do believe them to be in their best interest. Hanley believes that companies constrained by the JOBS Act’s restrictions who are penalized by lower prices for their securities continue to pursue an IPO under the protections of an EGC; specifically, the IPOs they studied seemed to suffer “significantly” higher rates of underpricing, a trend they believe is tied directly to the legislation’s more lax rules for transparency. Overall, our results are consistent with a large body of literature that shows that investors value transparency, Hanley wrote. In its absence, issuers are penalized by lower prices for their securities,” the team wrote.

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Susan Woodhouse examines maternal behavior and infant response to forge a path to more effective interventions for racially diverse and low-income families.

Susan Woodhouse challenges some long held beliefs about maternal attachment. Through a five-year, federally funded research project, Woodhouse, associate professor of counseling psychology, is investigating which aspects of mothers’ caregiving for their babies best predict children’s security of attachment, ability to regulate their emotions, and early indicators of mental and behavioral health. In an earlier study, Woodhouse found that in racially diverse and low-income families, a mother’s sensitivity does not appear to be a key predictor of secure attachment.

Most prior research in this area has involved primarily white, middle-income families. Woodhouse instead studies low-income mothers of diverse racial and ethnic backgrounds. She found among them many mothers whose babies feel safe and secure, in spite of what might appear to be insensitive parenting styles.

“We hope to learn whatMom behaviors make the most difference in predicting baby outcomes,” says Woodhouse, the study’s principal investigator. “If we want interventions that work when there are limited resources, we want to focus on what matters most.”

A $2.1 million grant from the National Institute of Child Health and Human Development, one of the federal government’s National Institutes of Health, supports her quest to find answers and close that gap.

The grant, titled “Caregiving, Attachment, and Regulation of Emotions,” or CARE, allows Woodhouse to observe 200 primarily low-income women and their infants at 6, 9, and 12 months of age to determine what behaviors lead to a secure attachment, as well as the actions that detract from such attachment. In addition, Woodhouse examines other important child outcomes, such as early signs of behavioral problems as well as physiological indicators of how babies react to and recover from stress and how babies manage their emotions and focus their attention. All of these are important outcomes in terms of later school readiness and mental health.

“There is a gap in our understanding of what parenting behaviors really make the most difference,” Woodhouse says.

Illustrations by Laurindo Feliciano

Susan Woodhouse is an associate professor of counseling psychology whose research interests include attachment, emotion regulation, parenting, prevention and psychotherapy. She received her Ph.D. from the University of Maryland at College Park.

ENCOURAGING MATERNAL ATTACHMENT
UNDERSTANDING INFANT SECURITY

Woodhouse began the study in March 2012 as a faculty member at Pennsylvania State University and continued when she arrived at Lehigh later that year. More than 100 mothers and babies have enrolled so far, and Woodhouse has begun to analyze the data she’s already collected. She concentrates on the simple but powerful act of a mother holding her child “chest-to-chest” to calm the infant’s crying.

“My new discovery is the key importance of chest-to-chest soothing when infants cry,” says Woodhouse. “Even if a mother is making a lot of mistakes and being insensitive along the way, as long as she finally relents and comes through in the end by soothing the baby chest-to-chest, that baby will be secure. She doesn’t even need to do it every time. As long as she does it at least 50 percent of the time, that baby will still be secure.”

In fact, even if a mother does not hold her child chest-to-chest at least half of the time the child cries, her baby can still feel secure if the mother displays what Woodhouse calls “calm connectedness.” For example, babies were secure if their mothers returned their gaze or if their mothers carried them to take a walk or if their mothers averted their gaze or if their mothers carried them to take a walk or if their mothers carried them to take a walk or if their mothers carried them to take a walk or if their mothers carried them to take a walk or if their mothers carried them to take a walk or if their mothers carried them to take a walk or if their mothers carried them to take a walk or if their mothers carried them to take a walk or if their mothers carried them to take a walk or if their mothers carried them to take a walk or if their mothers carried them to take a walk.

The IMPACT OF STRESS

Each participant must have a child 6 months of age or younger who is not yet crawling. Woodhouse and her team have been enrolling women at community events, housing projects, child-care centers and clinics. Team members distribute brochures to anyone who might qualify and explain that they’re studying “how mothers and babies deal with everyday feelings and stress that are a normal part of raising healthy children.” Researchers observe and test mothers and babies in their homes and in a lab-playroom, which offers a comfortable couch, age-appropriate toys and two cameras mounted near ceiling corners.

During the first two-hour visit, when the baby is 6 months old, researchers check heart rates and seek minutes for the home visit to assess stress levels of the mother and baby during normal tasks, such as putting a child into a car seat.

The ability to adapt to stress and regulate emotions is key in mental health and school readiness. By watching how babies’ cortisol levels rise after a simple stressor and then how quickly this stress hormone returns to normal, Woodhouse can gauge whether a good mother-baby relationship buffers children from the negative effects of stress.

Because babies’ heart-rate variability is an important marker of infant emotion regulation, electrocardiogram (ECG) wires are attached to the mother and child and the baby is placed into a car seat. The baby is 12 months old, the mother brings him or her back to the lab for another two-hour testing and observation session. That’s followed by two at-home observations, each 15 to 2 hours in duration, a week apart. CARE staff members are trained in how to videotape and rate the behaviors they observe.

After they complete the testing, participating mothers are offered social services, as well as parenting support through a program Woodhouse considers one of the most promising interventions available. The program, “Circle of Security,” uses a video to stimulate learning and discussion about infant needs. By playing a game called “Name that Need,” mothers learn whether a baby needs to be soothed or encouraged to explore. In addition, mothers are supported in exploring how to better meet their own baby’s needs.

“The RESULTS BELONG TO THE COMMUNITY”

Woodhouse participates in a community-research partnership called Parents and Children Together (PACT). As a PACT member, she receives guidance and suggestions from a PACT Community Advisory Board, which includes community leaders and grassroots community members, about how to best engage the community. It was the Community Advisory Board’s idea, for example, to give mothers parenting support at the final visit.

“They wanted to make sure each mom would immediately get something positive to support her parenting, in addition to contributing to building knowledge about mothers and babies in the community,” says Woodhouse, who regularly reports back to the Community Advisory Board’s idea, for example, to give mothers parenting support at the final visit.

“We HOPE TO LEARN WHAT MOM BEHAVIORS MAKE THE MOST DIFFERENCE IN PREDICTING BABY OUTCOMES, IF WE WANT INTERVENTIONS THAT WORK WHEN THERE ARE LIMITED RESOURCES, WE WANT TO FOCUS ON WHAT MATTERS MOST.”

New Discoveries

Woodhouse and doctoral student Netta Admoni recently analyzed preliminary data from the CARE study regarding CARE heart-rate variability data, an index of parasympathetic nervous system activation, as mothers and babies move through a task, and then after the mother's response if the mother also assessed the baby's behavioral response and whether the mother then did a “take a break.” Mothers spend stressful minutes engaging in negative behaviors with their babies, and then look away for two minutes before finally reengaging with the baby. Findings suggest that mothers who provide higher-quality caregiving to their infants who seem more com- fortable with their mothers who provide lower-quality caregiving to their infants who show physiological signs of stress when mothers look away and then show signs of greater stress, at a biological level, when their mothers reestablish contact with them. Woodhouse’s lab is the first to identify different changes in babies’ heart-rate variability depending on quality of care.
Researchers in Lehigh’s ATSS Center work to fortify structures against natural disasters, protecting life and property.

While it may not garner as much attention as fighting terrorism or growing the economy, improving America’s infrastructure—its roads, its bridges, and no less importantly, the resiliency of its built civil infrastructure—has one of the country’s most pressing challenges.

Lehigh University’s Advanced Technology for Large Structural Systems (ATLSS) Engineering Research Center has been conducting and hosting groundbreaking research on improving the resiliency of structures in earthquakes since it opened in 1986. In September 2015, Lehigh was awarded a highly competitive grant by the National Science Foundation (NSF) to establish an experimental facility associated with the Natural Hazards Engineering Research Infrastructure (NHERI) program. Led by James Ricles, the Bruce G. Johnston Professor of Structural Engineering and the ATLSS Deputy Director, and Richard Sause, the Joseph T. Stuart Professor of Structural Engineering and Director of ATLSS, the five-year, $5 million grant will enable ATLSS to expand its scope into fortifying structures against other natural disasters.

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“The country’s infrastructure has really deteriorated,” says Ricles. “There’s a push to develop resiliency, particularly in the aftermath of recent natural hazards such as Hurricane Sandy. There’s a need to have structural systems and the community as a whole become more resilient to natural hazards.”

The ATLSS Center contains some of the largest structural testing facilities in the world. Its equipment allows for hybrid seismic testing, where experimental simulations are combined with real-time numerical simulations to enable researchers to investigate the behavior of large-scale structural components during seismic events. The center was funded with financial support from the NSF and for a decade was part of the George E. Brown Jr. Network for Earthquake Engineering Simulation program, which supported innovation and education in earthquake engineering. Today it’s a part of the NHERI program.

ATLSS researchers have been responsible for a number of breakthroughs in earthquake engineering, including box columns with passive and semi-active dampers, and self-centering structures that allow seismic loads. The ATLSS Center’s large-scale reaction wall, strong floor and hydraulic actuators allow researchers to do real-time earthquake simulations on actual test specimens that are constructed in the Center. “Let’s imagine you have a building resting on the ground and an earthquake occurs,” Ricles explains. “The building is going to be subjected to forces that develop as a result of the accelerations that are exerted on the inherent mass of the system. These forces are from the ground accelerations that develop as a result of the ground motion. Knowing the ground accelerations and inherent mass of the system, we can determine these forces, so we don’t need to shake the ground and can fix the building to the laboratory strong floor and apply these forces directly to the building.”

As engineering concepts for structural systems have improved, the failure of nonstructural components has become the weak link in structural resiliency, Ricles says. “The reason a building may go offline includes structural damage,” he says. “A building, however, may also be declared as unsuitable for occupancy if nonstructural systems in the structure are damaged. For example, if the sprinkler system no longer functions, then you can’t occupy the building because of fire safety. If the elevators go out, there’s no access for the physically handicapped. Clogging is, of course, an issue.”

In September 2015, a team led by Paolo Bocchini, assistant professor of civil and environmental engineering, won a $2.2 million NSF grant “to establish and demonstrate a comprehensive framework that combines models of individual infrastructure systems with models of their interdependencies for the assessment of interdependent infrastructure system resilience for extreme events under uncertainty.”

“The PRMRes platform (Probabilistic Resilience Assessment of Interdependent Systems) will emphasize a probabilistic approach that permeates all aspects of the modules, including the interdependencies,” Bocchini says.

Lehigh will use the $5 million NSF grant to fund operation of the Center. Researchers from around the world will be able to submit proposals and won’t have to pay to use the facility. They’ll be looking to discover ways that buildings can remain online following natural disasters.
THE CHANGING FACE OF MARRIAGE IN MALI

Polygyny, a seemingly outdated vestige of rural life, has evolved into an institution compatible with modern living in urban Mali. Bruce Whitehouse examines how marriage is understood and practiced in West Africa—and the potential consequences of its changing meaning.

During a wedding ceremony in Bamako, the capital city of the West African nation of Mali, couples pledge their commitment to one another in front of family and friends. Brides wear white dresses, and ceremonies are often followed by elaborate celebrations with food and dancing. At first glance, the practice of marriage in Bamako appears similar to that of many Western cultures.

A check box on the required paperwork for a legally binding civil ceremony, however, draws a distinction.

Malian law requires couples to commit to either monogamy or polygyny when they marry. Checking the box for polygyny—a form of plural marriage in which a man is allowed more than one wife—does not require a man to take another wife at any point, but it leaves the option available. If a couple commits to monogamy, they are legally bound to that type of union unless both parties agree to legally change the agreement.

Fewer than one in five couples in the capital city of Bamako check the monogamy box, says Bruce Whitehouse, associate professor of anthropology. Monogamy, says Whitehouse, has taken on something of a bad name in Bamako.

A MATTER OF TRUST

Whitehouse, who first traveled to Mali as a Peace Corps volunteer, spent 10 months conducting Fulbright-funded field research on marriage and polygyny in Bamako. He interviewed individuals and led focus-group discussions, asking Malians to share their views and experiences with marriage. He sought to figure out how marriage is understood and practiced in an urban demographic and its impact on larger Malian society.

Whitehouse learned from his interviews that it wasn’t just men who didn’t want to check the box for monogamy—women were wary of it as well, although for different reasons.

Men avoid checking the monogamy box in order to hold the threat of polygyny over their wives, says Whitehouse. “And though marriage provides the social respectability that Malian women seek, many believe their husbands will be unfaithful, regardless of which box they’ve checked during the civil ceremony. They don’t trust the state to uphold the contract of monogamy, so the type of commitment made during the ceremony becomes somewhat inconsequential.”

“One inference that I can draw is that there’s this really high degree of mistrust between men and women before they get married, and it doesn’t necessarily end after they get married. Marriages are perceived as being more brittle than they used to be, and much more oriented toward material gain,” says Whitehouse.

THE ECONOMICS OF MARRIAGE

For a woman in West Africa, says Whitehouse, the number one route to economic security is through marriage.

Women have always had some economic autonomy within marriage, but a husband is expected to provide housing and food for his wife and children, says Whitehouse. In a climate of economic uncertainty in which modern urban households face high unemployment rates and skyrocketing food and housing costs, women are driven to approach their relationships strategically—far from the Western ideal of love, trust and exclusivity within marriage.

“The woman is, through her relationships with a man or sometimes multiple men that she winds up providing for her economic needs,” says Whitehouse. “Anecdotal evidence suggests that women are taking multiple partners before marriage and possibly during marriage because they want to secure their economic future. And they’re counting more and more to see marriage as primarily an economic transaction.”

This mindset, says Whitehouse, is causing a great deal of friction between young men and women.

“Women see men as being inherently unfaithful and insatiable liars and manipulators,” he explains. “And the young women are saying, ‘Well, if they’re going to treat us that way, we might as well maximize our return on the social respectability that Malian women seek, many believe their husbands will be unfaithful, regardless of which box they’ve checked during the civil ceremony. They don’t trust the state to uphold the contract of monogamy, so the type of commitment made during the ceremony becomes somewhat inconsequential.”

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This mindset, says Whitehouse, is causing a great deal of friction between young men and women.

“Women see men as being inherently unfaithful and insatiable liars and manipulators,” he explains. “And the young women are saying, ‘Well, if they’re going to treat us that way, we might as well maximize our return on the social respectability that Malian women seek, many believe their husbands will be unfaithful, regardless of which box they’ve checked during the civil ceremony. They don’t trust the state to uphold the contract of monogamy, so the type of commitment made during the ceremony becomes somewhat inconsequential.”

“One inference that I can draw is that there’s this really high degree of mistrust between men and women before they get married, and it doesn’t necessarily end after they get married. Marriages are perceived as being more brittle than they used to be, and much more oriented toward material gain,” says Whitehouse.

THE ECONOMICS OF MARRIAGE

For a woman in West Africa, says Whitehouse, the number one route to economic security is through marriage.

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**A VERY MODERN INSTITUTION**

The urban version of polygyny, Whitehouse discovered, differs from its rural counterpart. During his time in the Peace Corps, Whitehouse lived with a Fulani family in a rural community.

“Noise of the adults in that family had even a primary school education,” says Whitehouse. “It was easy for me to associate polygyny with that context. But you go into the urban setting, and you’ve got these more elite, educated, modern families, and polygyny is not only on the table, but it seems to be adapting. It turns out to be, in some senses, a very modern institution, or at least compatible with modern life.”

While rural polygyny can create a sense of unity, with multiple wives living in the same household and raising their children as siblings, a new phenomenon of urban polygyny sees each co-wife and her children living separately and maintaining a deliberate distance from the other co-wives and their children. This arrangement, says Whitehouse, allows wives to maintain the illusion that their union adheres to certain modern norms.

“The love angle is still important and people aspire to that, but it turns out not to be achievable for a lot of them in their daily lives,” he explains. “So they wind up falling back on strategies that they hope will at least provide them with some kind of security.”

Regardless of intent or approach, marriage is an obligation in Mali, says Whitehouse. Changes to the meaning and practice of the institution affect the entire society.

“It’s not a question of if, it’s when you’re going to get married, and how much of your life you’re going to stay married,” he says. “Aside from that certainty, we’re seeing that almost everything else connected to marriage is changing in West Africa. I think this is going to put a great deal of stress—already has put a great deal of stress—on relations between men and women, parents and children. I think it’s going to have very far-reaching consequences.”

**Instability in Mali**

In early 2012, strengthened by arms from the 2011 civil war in Libya, rebels and Islamist militants gained control of northern Mali, upsetting the country’s relative stability. The nation then experienced a military coup in March of that year, and Islamist rebel groups capitalized on the chaos. A French-led offensive intervened, but remaining militant groups have since attacked Malian soldiers and United Nations peacekeepers. More recently, an attack on a luxury hotel in Bamako in November 2015 targeted civilians. Twenty-two people were killed.

Whitehouse’s expertise is frequently sought by the U.S. government and the governments of other nations. Journalists and non-governmental agencies working in the region, he recently coordinated a special issue of the journal African Security examining the big picture of state sovereignty in Mali and throughout northwest Africa.

“Journalists want to know what might happen next,” says Whitehouse. “I don’t think I’m a pessimist. I try to be hopeful for the future, but I also try to be a realist. Under the surface there’s lots of serious, and those problems that had accumulated during the period before the coup, most of them still haven’t been addressed. I try to draw attention to those problems. They have to do with really basic things like the rule of law, corruption.”

**A REQUIEM BY AND FOR CHILDREN**

Steven Sametz’s ‘A Child’s Requiem’ honors the children and adults killed during the shooting at Sandy Hook Elementary School in 2012.

March 5, 2015 marked the premiere of Lehigh composer Steven Sametz’s oratorio, A Child’s Requiem, written to honor the 26 children and six adults who were killed during the shooting at Sandy Hook Elementary School in 2012. At the first performance of the piece, held at the University of Connecticut’s Jepsonian Center for the Performing Arts, the university’s Symphony Orchestra and Concert Choir joined the Chorus Angelicus Children’s Choir, soprano Janani Sridhar and tenor Gregory Zavracky under the direction of Jamie Spillane.

Sametz, the Ronald J. Ulrich Professor of Music and director of the Princeton Singers, an elite singing group, has received commissions from the National Endowment for the Arts, the Connecticut Council on the Arts and the Santa Fe Music Festival. He has also composed music for Chanticleer, the Dale Warland Singers, the Philadelphia Singers, the Pro Arts Chamber Choir, the Santa Fe Desert Chorale, the Connecticut Choral Artists and the King of Thailand.

His recent guest-conducting invitations include appearances with the Taipei Philharmonic Foundation, the Bermuda Music Festival, the New York Chamber Symphony and the Netherlands Radio Choir.

The Lehigh Valley premiere of the oratorio included 300 musicians: the 65-member Lehigh Choral Union, which comprise part of Lehigh Choral Arts, as well as the Princeton Singers, Princeton Girlchoir, an orchestra, soprano Tami Petty and tenor David Vanderwal.

**“I HOPE TO OFFER THIS PIECE AS A GIFT TO THE TOWN OF NEWTOWN AS THEY HEAL FROM THEIR TRAGIC LOSS.”**

In an interview conducted by Silagh White, director of arts engagement and community cultural affairs at Lehigh, and Andrew Cassano, administrative director of the university’s Zoellner Arts Center, Sametz described A Child’s Requiem as “a response to a child’s loss and grief.”

The Sandy Hook Elementary School shooting occurred on Dec. 14, 2012, in Newtown, Conn., and was the deadliest mass shooting at a high school or grade school in U.S. history. Sametz, a native of Westport, Conn., said A Child’s Requiem “resolves around a libretto, much of which was written by children.”

“It’s paired with lines from the American poets Ralph Waldo Emerson and Emily Dickinson and H.D. (Hilda Doolittle, who was born in Bethlehem). It’s kind of a collision between the adult world and the world of innocence.”

“I hope to offer this piece as a gift to the town of Newtown as they heal from their tragic loss.”

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**MUSIC**

**A Child’s Requiem:** The Lehigh University Choral Composer Forum, a summer course of study designed to mentor emerging choral composers. He serves as the national advisor on composition for the American Choral Directors Association. In 2014, Sametz conducted his choral symphony, A Child’s Requiem, which comprise part of Lehigh Choral Arts, as well as the Princeton Singers, Princeton Girlchoir, an orchestra, soprano Tami Petty and tenor David Vanderwal.

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In the fall of 2013, the U.S. government, held hostage by a venomous and deadlocked Congress, just barely averted a crippling default on its debt—an event that could have caused a crisis not just on Wall Street, but throughout the entire world economy. The nation—and the world—had a handful of women to thank.

Lawmakers had for weeks been locked in a historic budget showdown that ultimately saw almost the entire federal government shut down. Nearly a million federal workers were sent home. Vital services were eliminated. And the cost to the U.S. economy counted? According to some estimates, it ran in the billions.

Even despite the massive costs, however, the political fighting raged. As the standoff dragged into mid-October, Republicans and Democrats remained far from an agreement on the central issue of the shutdown—President Obama’s Affordable Care Act—and it seemed increasingly likely that the shutdown would linger on.

The debt default, and all its frightening impacts, loomed as a real possibility.

That’s when a bipartisan coalition of women from the U.S. Senate stepped up to end the crisis. Maine Republican Susan Collins kick-started the effort, and quickly found allies in Republican colleagues Lisa Murkowski of Alaska and Kelly Ayotte of New Hampshire, as well as Democratic senators Barbara Mikulski, Amy Klobuchar, Jeanne Shaheen and Heide Heitkamp.

The women held wildly different political views, but they also realized the nation, at that moment, needed a great deal less partisanship and a whole lot more leadership. Within short order, Collins and her team colleagues garnered enough support from their male colleagues to bring the shutdown to an end.

“It’s unlikely that women are always better leaders. My question was, in what type of contexts would they be more likely to make a positive difference?”

Rising to the Challenge

Sen. Susan Collins was a key figure in the movement to end the government shutdown in 2013—and she was backed by a coalition of several other female senators as well.
The idea of the study was not to come to the final answer as to which sex is more adept at leadership—such an assertion, Post says, very likely does not exist—but rather to pinpoint the strengths unique to each, as well as some of the organizational circumstances in which each sex are more likely to thrive—or fail. Her study helped her do precisely that.

According to her findings, which were published in the Journal of Organizational Behavior, women appear to excel in the unique and important management task of unifying large, diverse and complex teams—teams that consist of individuals from different departments with diverse specialties, and teams whose members are spread out over a large geographic area. Such teams are notoriously difficult to manage, simply because workers in them don’t necessarily understand each other, or the work each respectively contributes.

Post found that women proved themselves to be adept at leading teams to bridge the sometimes wide gaps in function, and in culture—between team members. Most likely, she says, that’s because women tend to be more aware of potential relationship problems and possibilities than men—and more willing and able to repair those relationships, too.

Supporting this hunch, Post found that the more complex teams she studied that were managed by women had greater cohesion and more positive, beneficial and constructive interactions than similarly complex teams that were managed by men. The individuals who reported to those women leaders, Post says, felt that they “had a voice.”

“T here appear to be some key differences between men and women in the context of how they relate to others,” Post says. “Men will generally think independently, while women will think more interdependently. This makes them more likely to see success leading functionally diverse teams—those where the different groups interdependently. This makes them more likely to see success leading functionally diverse teams—those where the different groups

Post’s work shows that women are more likely than men to be successful when leading large, diverse and complex teams.

In addition to the unique leadership styles and skills of women and men, with the goal of uncovering additional specific situations in which one sex or the other may be more effective, generally speaking, when it comes to organizational success. Prompted by the assertion of a political and budget crisis on the senate floor, she is also turning her attention to understanding the potential role of female leadership styles in preventing and mitigating organizational crises.

“I’m interested in trying to unravel this a bit more,” she says. “Really, what are the qualities that women leaders bring to the workplace? I don’t see this work as being about elevating women. It’s about pulling out their unique—and sometimes invisible—competencies and understanding how they might deliver better outcomes.”

From hip-hop to mass incarceration, James Peterson wants to reach as many as possible. With his first book, The Hip-Hop Underground and African American Culture, Peterson explored the concepts of mass incarceration.

Peterson’s work shows that women are more likely than men to be successful when leading large, diverse and complex teams. The studies were divided into two groups: one set was examined for accounting returns, profitability, or how well the company used assets to generate earnings, the other for performance as defined by the market or shareholders.

Post and Byron found female board representation to be positively related to profitability. Moreover, that relationship is more positive in countries with stronger shareholder protections, perhaps because shareholder protections motivate boards to use the different knowledge, experience, and values that each member brings to the board. (Without such a strong motivation, the voices of female directors, when they are in the numerical minority, sometimes are not heard or discounted.)

The analysis also revealed that while there is little relationship between female board representation and market performance, the relationship is positive in countries with greater gender parity and negative in countries with low gender parity. Additionally, Post and Byron found that female board representation actually increases the board’s “primary responsibilities—monitoring and strategy involvement.”

James Braxton Peterson is director of Africana Studies at Lehigh. He is the founder of Hip Hop Scholars, LLC, an association of hip-hop generational scholars dedicated to researching and developing the cultural and educational potential of hip-hop, urban, and youth cultures. He received his Ph.D. from the University of Pennsylvania.
Chao Zhou’s work has received a $500,000 grant from the National Institute of Biomedical Imaging and Bioengineering to continue his work exploring the use of light as a possible alternative stimulator for artificial pacemakers.

As electrical systems go, the human heart is one of nature’s most durable. Every minute, your heart beats about 80 times; every hour, nearly 5,000 times. By the time you are 70, you will have recorded about 3 billion heartbeats. Each of those heartbeats is a marvel of coordination between the heart’s four chambers—the right and left atria, and the right and left ventricles. As the atria fill with blood, an electrical signal is generated that causes both to contract and push blood into the ventricles. The ventricles then contract and push blood through the pulmonary and aortic valves and out to the rest of your body. The ventricles then relax, the atria fill again with blood, and the cycle repeats.

If injury or disease disrupts your heart’s electrical system, you can be fitted with a battery-powered pacemaker that signals the cardiac tissue, helping your heart regain its regular rhythm. Electric pacemakers are used today by an estimated 3 million people around the world.

Pacemakers have helped scientists learn more about the heart’s physiology and its disorders, says Chao Zhou, but they have their limits. They must be surgically implanted. They are not specific to heart tissues and can cause unwanted contractions in other areas of the chest. They produce inhomogeneous areas of depolarization and can also generate toxic gases, alter pH levels and cause tissue damage.

Zhou, assistant professor of electrical and computer engineering, and his colleagues have taken the first step toward developing a laser pacemaker that could one day stimulate the human heart noninvasively with light signals.

The researchers have built a microscope that paces the tiny heart of the common fruit fly without touching it, while simultaneously controlling its heart function, monitoring its performance and taking high-resolution images of it at the microscale.

The system uses two optical technologies—optical coherence tomography (OCT) and optogenetics—to generate pulsed blue light signals that pace the fruit fly’s heart during the three stages of its life: larva, pupa and adult.

The group reported its results recently in Science Advances, a journal published by Science magazine. Their article, titled “Optogenetic pacing in Drosophila melanogaster,” was written by Aneesh Alex, a former postdoctoral research scientist at Lehigh, and co-authored by Zhou and by Airong Li and Rudolph E. Tanzi, both of the Genetics and Aging Research Unit of Harvard Medical School’s Department of Neurology. The project has been funded by the National Institutes of Health (NIH).

Optogenetics uses light to control and study the activities of living cells that have been genetically modified with a light-sensitive protein. OCT combines light waves, usually from the near-infrared portion of the electromagnetic spectrum, with interferometry to capture microscale images from deep within biological tissue and other media that scatter optical signals.

Optogenetics was invented by researchers at Stanford University a decade ago to study nerve cells. In 2010, says Zhou, two other groups published articles about the use of optogenetics to pace the heart of the zebrafish. At that time, Zhou, a postdoctoral researcher at the Massachusetts Institute of Technology, was using OCT to study fruit flies in collaboration with researchers from Harvard Medical School.

“NIH had awarded me a grant to improve OCT technology to enable the molecular imaging of cell features,” says Zhou. “I came up with a new idea, which was to use optogenetics to stimulate heart pacing and OCT to monitor heart function.

Zhou’s group has also used optical coherence microscopy to study the influence of the circadian rhythm gene on the fruit fly heart.

Chao Zhou’s research interests include biomedical optics, optical coherence tomography (OCT), optical coherence microscopy (OCM), diffuse optical spectroscopy/imaging and laser speckle imaging. He received his Ph.D. from the University of Pennsylvania and served as a postdoctoral associate at the Massachusetts Institute of Technology.
“We found that we could shine a light to control the heart rhythm and then use OCT to confirm that the heart was beating and to see how it was beating. We used OCT to see the fly’s heartbeat in real time.”

The fruit fly, known scientifically as Drosophila melanogaster, offers several advantages for optical study, says Zhou. First, biologists have obtained the complete genome sequence for the fruit fly and then in a mouse.”

“We don’t know the answer to these questions yet. We’re still trying to figure out how to do near-infrared stimulation.”

“OCT is like ultrasound, which sends high-frequency sound waves into tissue and reads their images of human kidney samples,” explains Zhou. “It’s a clinical practice, but it’s not completely lost. You would have to guide this light to the region where you want it in order to do optical pacing.”

For human beings and fruit flies, says Zhou, “70 to 80 percent of the genome is identical. You can easily test a human gene and see the fly’s heartbeat in real time.”

“OCT is similar. It uses near-infrared light instead of sound. The light has a shorter wavelength and, thus, gives us much finer resolution, at the microwaves. As the light is reflected from different depths in the tissue, the delay in the reflecting of the light signal tells you how deep the signal has penetrated into tissue. From this, we can generate a cross section of a sample from beneath the surface of the tissue.”

“With bigger animals come challenges. How do you insert light-sensitive proteins? How do you do near-infrared simulation? An OCT and OCM, results can be obtained within minutes.”

“Nothing in the literature showed this. It is difficult to detect it without the noninvasive imaging tools we have.”

“I don’t know the normal rates of those questions yet. We’re still at the hypothesis stage, but the technology now exists to make it possible to think about them.”

“With optical coherence microscopy (the Public Library of Science), Zhou and his collaborators from Harvard Medical School, joined by researchers from Zhejiang University in China, reported that the circadian clock gene plays a major role in the development of the structure and function of the fruit fly heart.”

“Collectively, our studies provided novel evidence that the circadian clock genes play an essential role in heart morphogenesis and function.”

“OCT and OCM work very quickly. OCT is a sophisticated imaging technique with a high resolution that works very quickly. OCT and OCM are used in clinical practices,” says Zhou. “And because the fruit fly heart is so small, we need a very sophisticated imaging technique with a high resolution that works very quickly.”

“Otherwise, we get a very blurry image.”

To begin their experiments, Zhou and his group bred a genetically altered strain of fruit flies by inserting a light-sensitive protein (taken from algae) into their hearts. When the researchers shone a light on a fly, they observed the corresponding change in the beat rate of the fly’s heart. When the laser was pulsed at 10 times per second, for example, the heart rate accelerated to 10 beats per second, in perfect synchronicity with the laser.

“One key advantage of our system is that it is completely noninvasive,” says Zhou. “We can do experiments over and over again on the same specimen.”

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“It’s a clinical practice, but it’s not ideal,” says Zhou.

“Right now, optical biopsies face practical limitations. Depth, for example, is a challenge. So far, OCT and OCM work only up to about 2 millimeters, similar to the depth of skin cancers. In cases of breast cancer, an image is usually obtained during surgery to identify areas of potential cancer and possibly help reduce the need for a second surgery. For now, Zhou is working on his own technique to develop imaging procedures using this technique.”

“We’re pretty optimistic. With further development, we can make this real-time optical biopsy possible, and that can hopefully change the clinical practice,” says Zhou.
AN ENIGMA IN MONGOLIA

Seismologist Anne Meltzer and an international team of researchers study the Hangay region of Mongolia in an effort to gain better understanding of the generation of large earthquakes.

Near the geographic center of Asia, north of China and Tibet and south of Russia, the Hangay and tran-Hovsgol mountain ranges cover about 425,000 square kilometers (164,000 square miles) of Mongolia and look out over an arid and mostly treeless steppe.

But in the Hangay we see high topography, and the question is why.

The researchers have examined several factors that might answer that question. The continental crust of the Hangay Dome looks to be thicker than the average continental crust,” says Meltzer. “This helps support the topography. If you look deeper inside, the lithospheric plate [the crust and rigid part of the upper mantle] appears anomalously thin, and the deeper, warmer part of the mantle is closer to the crust. This could account for the relative height of the Hangay Dome.”

The team has concluded that the high topography is a function of several processes. Early plate collisions, says Meltzer, thickened the crust, producing a state of gravitational equilibrium between the earth’s crust and mantle that allows the crust to “float” at a high elevation.

“It’s like an iceberg,” says Meltzer. “We see the tip of the iceberg but not the larger mass beneath the water. With the Hangay, we see a high mountain, but underneath is a root of low-density material propping it up. Its relative thickness makes the crust more buoyant and therefore capable of supporting a high topography like that of the Hangay in the interior of a continent.”

A second process, says Meltzer, could be a dynamic flow of material inside the mantle that generates high topography.

Meltzer is looking to start a new research project in Indonesia. “The relative motion of the Indian, Australian, and Eurasian plates provides an opportunity to study the transition from plate subduction to continental collision.”

The country is at considerable risk from seismic hazards. “We hope to get undergraduates involved from Lehigh and Indonesia. One outcome from this research would be a better understanding of the seismic hazards and how to mitigate the risk of these hazards.”

Anne Meltzer is the first Francis J. Trembly Chair in Earth and Environmental Sciences. She studies earthquakes and the structure of the earth through naturally and artificially generated seismic waves. Meltzer has conducted research in Pakistan, Tibet, Mongolia, North and South America, and the Caribbean. She is a former chair of the board of directors of the Independent Research Institutions for Seismology (IRIS) and received her PhD from Rice University.
If you’re feeling sick and can’t get to a doctor, so you post a question about your symptoms on an online health forum. In doing so, you’ve left a digital footprint.

You’re hungry and in an unfamiliar neighborhood, so you use your smartphone to search for restaurants. Another footprint.

You frequent a particular online vendor, so you store your credit card information in your account to expedite checkout. Yet another footprint.

Regardless of how you’ve used your computer or mobile device, when you enter information into a website, search engine or social media platform, you’ve left a digital breadcrumb of sorts that can potentially be seen or tracked by others.

“We have left so many footprints on the Internet, and we have no idea what type of information we have left,” says Ting Wang, assistant professor of computer science and engineering. “[And] if someone wants to dig in, they can find out.”

There’s no shortage of digging going on, either. When former National Security Agency subcontractor Edward Snowden leaked classified information in 2013 about the NSA’s surveillance activity, he triggered a global conversation about privacy in an age where most everything, including our personal data, is digitized.

“Privacy, whether it’s abused by attackers or whether it’s abused by our own government, is a very big concern,” says Daniel Lopresti, professor and chair of computer science and engineering and director of Lehigh’s Data X Initiative. “So privacy and security go together hand in hand, and the bigger rubric is trustworthy computing—can we trust the systems?”

Today, individuals with malicious intent operate from anywhere in the world, attempting to access and manipulate software, networks, physical systems and the data stored within each of them. The protection of personal information has become a critical issue, and Lehigh researchers are working to strengthen our systems and bolster user trust in a variety of ways.

Demonstrating the Problem

The ultimate goal in privacy research, says Wang, is to raise people’s level of concern by making them aware of the risk. In one area of his systems-based work, Wang and his team use data mining and machine learning tools to understand and quantify privacy risk.

Many online systems request basic personal information, such as age, sex and ZIP code, but allow users to operate under pseudonyms or avatars, providing a sense of privacy. In not providing a full name, people assume they can’t be identified.

“Many think this is effective protection,” says Wang. “[But] there are attacks that can break the protection and reveal some sensitive information about people.”

Even without immediate access to names, an attacker can use what is known as a “linking attack,” connecting one particular dataset with public datasets such as voter registration lists. Correlating the datasets can reveal user identities. In fact, says Wang, 96 percent of United States citizens can be uniquely identified by just three attributes: ZIP code, age and gender. In the case of medical information, correlating data can reveal such private details as an individual’s disease or other health affliction.

In a recent paper currently under submission, Wang and colleagues Shouling Ji, Qinchen Gu and Raheem Beyah, all of the Georgia Institute of Technology, demonstrate the vulnerabilities within online health forums. They introduce in their study a new online health data de-anonymization (DA) framework, which they call De-Health. De-Health identifies a candidate set for each anonymized user in a forum and then de-anonymizes each user to a user in its candidate set. Applying De-Health to user...
generated datasets from popular forums WebMD and Healthboards, the researchers linked hundreds of anonymized users to real-world people and their personal information including full names, health information, birthdays and phone numbers. Wang and his colleagues hope De-Health will help researchers and policymakers improve the anonymization techniques and privacy policies utilized on websites like these.

Beyond exploring risk, Wang focuses on building energy-efficient tools that can help people understand the potential privacy leakage, or privacy price, of the things they do and say online. He also investigates protection mechanisms that will help individuals control who has access to their information. There's a balance, he says, in the amount of information shared and the service or results received.

"There's no free lunch with privacy," says Wang. "Companies need information to personalize services. Everyone understands that. But no one understands [if] the information is too much, if it reveals too much about themselves. ... Society lacks an understanding of how the system of data works."

### HIDING INFORMATION

Even when users are aware of the risks, sensitivity to security can go away on the Internet. Mooi Choo Chuah, professor of computer science and engineering, studies ways to protect that data and defer it from network-based attacks.

静脉信息的演变在运营系统中，你堆有新的变化，其中一种类型是不显眼的，涉及对患者的安全数据。关于这种类型的数据，获取随信息流共享的其他医院，也可以为改进服务，必要时，需要更新安全数据。当数据在安全数据上存储的用户，对信息敏感度降低，当获取信息时，需要在保护信息基础上。舒查的加密设计组也使患者提供者能够学习，从而降低对别的人的敏感度。如果不对信息敏感度，数据可以被分享和探索计算过程，对数据学习。但是，只有授权用户与适当密钥的可以查看实际数据。这对于数据下没有的安全数据。

"(if) the least way to perform data mining," says Chuah. "You cannot correlate your information to a public cloud like Amazon, but they have no idea what your data is because it's an encrypted form."

### DISGUISE INFORMATION FLOW

Data is not the only thing that can divulge information about users. The way it flows reveals quite a bit as well. Data mining techniques over encrypted data allows for data mining without the risk of unauthorized access. Each recipient will in turn mail the letter to the next, unaware of the contents within. To disguise the journey of the letter, the sender might put the envelope inside another envelope and place that one inside yet another envelope, addressing each envelope to a different recipient. Each recipient will in turn mail the letter to the next, unaware of the start or end points of the communication, and eventually the letter will reach its intended recipient. This method provides information flow security, but it comes at a cost time. The same is true with electronic transmission in a wireless network, as Venkitasubramanian's work also involves understanding a fundamental trade-off: the price paid for information flow security in terms of increased delay, network bandwidth consumption and additional use of resources.

"There's no free lunch with privacy," says Wang. "Companies need information to personalize services. Everyone understands that. But no one understands [if] the information is too much, if it reveals too much about themselves. ... Society lacks an understanding of how the system of data works."

"Every time you have new changes in an operating system, you tend to have some vulnerability, and the minute the attackers know that there is such vulnerability, they will launch an attack," says Chuah. "It's the simplest way to perform data mining," says Chuah. "You cannot correlate your information to a public cloud like Amazon, but they have no idea what your data is because it's an encrypted form."

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

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When it comes to mobilizing social change, people are motivated by action rather than ideology, says Nandini Deo. As part of her doctoral research on the women’s movement in India, Deo, associate professor of political science, set out to learn about how women’s organizations there were lobbying the government. But when she got to India, the lack of existing infrastructure for the groups to use in interacting with those in power caught her attention. Many of the goals of the women’s movement involve government policy and resources, Deo thought, so why wasn’t there any organized lobbying effort? Thinking it would be useful to demonstrate alternative approaches to influencing politics, Deo decided to also examine the Hindu nationalist movement, which has existed for about as long as the women’s movement but has had a different historical trajectory. Deo’s five years of fieldwork resulted in a book, Mobilizing Religion and Gender in India, which was published in November 2015. In it, Deo employs a historical comparative approach to examine the successes and shortcomings of Hindu nationalism and the Indian women’s movement, both of which have experienced periods of power and irrelevance.

**CHANGING TIMES, SHIFTING POWER**

The women’s movement in India was powerful in the 1950s but has since declined in influence. The movement initially provided services such as girls’ education and economic activities, but with growing trust in the state’s handling of those concerns, turned its focus instead to policy issues. However, in the 1970s, leaders of the movement realized the government was not addressing women’s needs. The controversial 1975-77 state of emergency declared by Prime Minister Indira Gandhi, which allowed the prime minister to rule by decree, further diminished trust. As a result, the women’s movement distanced itself from political parties and the state as a whole.

“Today [the women’s movement] doesn’t have a particularly powerful influence on most political parties, and because a lot of these groups are competing with one another for funding from large foundations and bilateral aid agencies, they also often find it difficult to work together,” says Deo.

Conversely, in the 1950s, when the women’s movement held power, the Hindu nationalist movement held very little. Having been implicated in the assassination of Mahatma Gandhi, Hindu nationalists were treated as outsiders in mainstream politics. Determined to earn the respect of the public, the group turned its attention to providing healthcare and education. Decades later, these efforts paid off.

“There are a lot of people who have interactions with [the Hindu nationalist] movement that they see as beneficial to them, even though the movement itself has goals that are pretty problematic for most Indians,” explains Deo. “So even though they don’t really agree with the ideology of the movement, their interactions with the individual activists are often positive. I argue that that’s partly why they’ve been...
able to come back into the mainstream of Indian politics.”
In fact, the Hindu nationalists won a significant majority in a 2014 election.
“They did much better than anyone was expecting, and I think part of the reason they were able to do that is because they have this sort of constant presence in Indian communities,” says Deo. “Even though sometimes among the elites in the party there can seem like there are problems and infighting that grassroots effort is very strong and is able to keep people connected to the movement.”
Ultimately, says Deo, when it comes to mobilizing support for a movement, actions speak louder than words.
People “want to feel like the person who’s asking them to show up to a protest or a rally is somebody who they can trust, somebody that they feel isn’t just using them,” she says. “I think that only comes from having lots and lots of interactions with somebody.”

**BROADER APPLICATION**

Deo believes the lessons from her research can be applied broadly. A movement might also serve as a means to understand world politics.
“In some of the politics that we see sort of playing out in other parts of the world, in North Africa, in the Mideast, we see support for relatively right-wing religious parties,” says Deo. “A lot of the reason why they get the support they do is because they are community activists. They provide services that people see as demonstrating that these people genuinely care about them, especially in the context of states that are not being very effective in providing the basics of education and healthcare and so on. I think that kind of appeal is very powerful.”

“The big picture story that I tried to tell in the book is that it’s not the ideas of the activists that shape whether people support them or not. It’s what they’re doing day to day,” she says.
Deo’s next steps involve India’s 2013 Companies Act, a provision of which requires all Indian businesses over a certain size to donate at least 2 percent of their annual profits to charity. This corporate social responsibility provision allows businesses to choose the charity that will receive their donation, Deo is exploring how companies choose their recipients and how social movements take advantage of the opportunities presented by the Act.
The Companies Act has the benefit of involving Indian companies, Deo says, so groups receiving funds are not just a part of the博弈 of the West, a charge often made against women’s organizations.

In summer 2015, Deo led a fieldwork project in India, interviewing individuals at some of the biggest companies in India to learn how they are responding to the Act. She is funded with a $3 million grant from the National Institute of Mental Health grant.

DuPaul and researchers from the University of North Carolina Greensboro and the University of Rhode Island are following students at six colleges over four years. Preliminary findings are sobering: Students with ADHD have lower grade point averages than students who do not have the disorder, struggle socially and engage in rates sexual behavior, he says. Both the ADHD and control samples have students who are doing well and students who are struggling. The researchers expect to compare the year-to-year progress of students in both groups.

“Do they grow further and further apart?” he asks. “Or do kids with ADHD get better over time as they learn the environment and get support services?”

In the BEST (Bridges to Educational Success for Teens) project, DuPaul and researchers from Ohio University are conducting a first-of-its-kind intervention program for high school students. The study is funded with a $3 million grant from the Institute of Education Sciences.

The researchers are tracking 96 students with ADHD who receive training in organizational and self-control skills and other areas. By monitoring the students, DuPaul says, researchers will be able to spot any red flags so that students can be connected to services, if needed.

“What we’re trying to do is give them skills to maintain self-regulation,” he says. “And that’s critical, because it cuts to the heart of the disorder.”

**SCHOOL PSYCHOLOGY**

**HOW DOES ADHD CHALLENGE STUDENTS?**

George DuPaul conducts three separate studies that span students’ educational stages from preschool through college.

Can a web-based training program help parents of 3- to 5-year-olds with attention-deficit/hyperactivity disorder (ADHD) learn strategies to ease their child’s transition to kindergarten? How do college students with ADHD fare educationally and socially year to year? Among teens with ADHD, how effective is a particular school-based treatment program in helping them succeed?

DuPaul, professor of school psychology, and fellow researchers are conducting three separate studies into the chronic neurodevelopmental disorder that affects individuals through adulthood. The research, which focuses on different age groups, spans students’ educational stages—from preschool through college.

“We’re really interested in how ADHD challenges these individuals,” says DuPaul, co-principal investigator on each project. “And what can we do to support them to be successful?”

To help preschoolers with ADHD, DuPaul and Lee Zem, professor of special education, developed Project PEAK (Promoting Engagement with ADHD Pre-Kinderpreparatory). A training program parents can take in face-to-face sessions or online. The study is funded with a $1.2 million Institute of Education Sciences grant.

Parents learn what to expect over the coming school year. Entering first graders, a training program parents can take in face-to-face sessions or online. The study is funded with a $1.2 million Institute of Education Sciences grant.

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George DuPaul’s research interests include the assessment and treatment of individuals with attention-deficit/hyperactivity disorder (ADHD) and related behavior disorders. He received his PhD from the University of Rhode Island.
If they’re willing to follow me, I’ll introduce them to the transformational power of hip-hop and the exciting ways it can inspire them to celebrate who they are,” says Kashi Johnson ’93 of the students in her course, “Act Like You Know: Hip-Hop Theatre.”

Now leading her eighth cohort of students, Johnson, associate professor of theatre, steps beyond lectures on the history of hip hop and immerses students in rich, dynamic experiences where they write and perform their own original works within the hip-hop aesthetic. A recent semester included four master teaching artists who, during individual weeklong residencies, taught students about the founding elements of hip hop: the DJ, breakdancing, the MC and graffiti art.

But the most inspiring element of the four-credit course is perhaps the final show, where students become a performance ensemble and share their newfound appreciation of hip-hop in a showcase of dramatic skits, rhymes, choreography and spoken word poetry.

“Empowering my students to find their voice and speak their truth is really what it’s about for me,” says Johnson.

“Hip-hop is the perfect performance vehicle because it demands that the person on stage or on the mic believes in their talent and abilities and is fearless in their self-expression.”

The class’s final exam, a live show performed for a large invited audience, is, as Johnson described in a 2013 TEDx talk, “a rite of passage, a definitive moment for students to declare who they are.”

Once they do, says Johnson, they never turn back.

Andrew Lustig ’10, now a professional performance artist, calls “Act Like You Know” “the most human experience.”

Johnson’s course, says Lustig, presents hip-hop as not only an art form, but also as history connected to important social and economic issues and racial relations in the United States. “It’s performance, yes, and it’s art, yes, but it’s also so deeply connected to people’s lives and to the world that we live in,” he explains. “All of a sudden, [hip hop] became both an artistic pursuit and an intellectual pursuit and a pursuit of social change and of social justice.”


“I’m excited about the possibilities,” says Johnson. “This class feeds into this generation’s desire to tell their stories in their way. They’re going to use their phones, laptops and social media to tell their story. This course is going to polish them up, expose them to quality performance techniques and empower them to not just put nonsense out there, but something of substance, something they can truly hang their hat on and be proud of.”

Kashi Johnson is an actress, director, poet and associate professor of theatre. She teaches courses in acting, African American drama and hip-hop theatre, and she regularly leads spoken word workshops in the Lehigh Valley. A Lehigh graduate, Johnson received an M.F.A. in acting from the University of Pittsburgh.

THE MOST HUMAN EXPERIENCE

Kashi Johnson leads students on a transformative journey of self-discovery via hip-hop theatre, empowering them to find their voice and speak their truth.

“I’VE BEEN ABLE TO GROW ORGANICALLY AND COMFORTABLY WITH INDIVIDUALS WHO CHALLENGE MY SELF-EXPRESSION WITH LOVE.” —KASHI STIRLING ’93
“WHEN YOU ARE ACTING OUT OF THE ACTUAL SELF, TELLING THINGS FROM THE HEART WITH TRUE FEELING AND EMOTION, YOUR VOICE GETS STRONGER AND YOUR PERFORMANCE BECOMES MORE POWERFUL.” —Amber Tang '16
Lehigh researchers have successfully demonstrated the first precisely controlled, biological way to manufacture quantum dots. This one-step method starts with engineered bacterial cells in a simple, aqueous solution and ends with functional semiconducting nanoparticles, all without resorting to high temperatures and toxic chemicals.

Born of an ideal collaboration among three Lehigh faculty researchers, this elegant technique has great potential for green manufacturing of quantum dots (QDs), which are used in transistors, solar cells, LEDs, lasers and medical imaging. Current industrial processes to produce them are messy, requiring toxic solvents, heat and high pressure.

Bryan Berger, associate professor of chemical and biomolecular engineering and bioengineering, wondered in 2012 whether the bacterial strain *Stenotrophomonas maltophilia* could be manipulated to generate QDs on command, since it had previously been known to exhibit heavy metal resistance.

Berger teamed up with colleagues Steve McIntosh, associate professor of chemical and biomolecular engineering and bioengineering, and Chris Kiely, the Harold B. Chambers Senior Professor of Materials Science and Engineering; Robert Skibbens, professor of biological sciences; and Ivan Korendovych, assistant professor of chemistry at Syracuse University. Together they won a $2 million grant in 2013 from NSF’s Division of Emerging Frontiers in Research and Innovation (EFRI) to prove the production of cadmium sulfide QDs using an engineered form of *Stenotrophomonas*. They tailored the bacteria to grow nanocrystalline metal sulfides including QDs, building on earlier research, which was funded by Lehigh’s Faculty Innovation Grant (FIG) and Collaborative Research Opportunity Grant (CORG) programs.

The beauty of a biological approach is that it cuts down on the production needs, environmental burden and production time quite a lot,” says Berger. Industrial processes take many hours to grow the nanocrystals, which then need to undergo additional processing and purifying steps. On the other hand, biosynthesis takes minutes to hours maximum to make the full range of quantum dot sizes (about 2 to 3 nanometers) in a continuous, environmentally friendly process at ambient conditions to water that needs no post-processing steps to harvest the final, water-soluble product. Because bacterial cells are much larger than the nanocrystals, researchers simply use a centrifuge to pull the cells away from the QDs in the solution.

More recently, the researchers have branched into creating lead sulfide QDs and are working with oxide-based materials, widening the range of QD practical applications. Their underlying technique allows them to control the particle size to fractions of a nanometer, an essential function, since particle size determines the QD’s optical and electronic properties.

Cell-based growth needs only basic equipment in a typical biochemistry wet lab setting. Using a process called directed evolution, researchers altered the bacteria so they would selectively produce quantum dots. Housed in a beaker containing water, cadmium and sulfur precursors, and minimum levels of carbon and nitrogen, the cells forgo most normal biological functions. They build quantum dots by sequestering metal ions from their environment.

Quantum dots are used in transistors, solar cells, LEDs, lasers and medical imaging. Current industrial production processes are time-consuming and environmentally unfriendly. Three Lehigh researchers have found a better, more natural approach.
THE BEAUTY OF A BIOLOGICAL APPROACH IS THAT IT CUTS DOWN ON THE PRODUCTION NEEDS, ENVIRONMENTAL BURDEN AND PRODUCTION TIME QUITE A LOT.

Brandon Krick inspires new engineering techniques with a 3-D wear model developed for a study of Triceratops teeth.

The three-horned dinosaur called the Triceratops might have been more complex than we thought. In fact, Triceratops’ teeth were far more intricate than those of any reptile or mammal living today.

Brandon Krick, assistant professor of mechanical engineering at Lehigh, and Gregory Erickson, professor of anatomy and vertebrate paleontology at Florida State University, joined a multi-university team of engineers and paleontologists to determine that the Triceratops’ teeth were far more complex than we thought. In fact, Triceratops’ teeth were far more intricate than those of any reptile or mammal living today.
and Technology in Kraków, Poland. Wojciech Misiolek conducts interdisciplinary research in materials processing and process engineering. He received his Ph.D. from AGH University of Science and Technology in Kraków, Poland. The Loewy Visiting Professor position, established in 1999, has brought to Lehigh noted researchers with unique expertise.

"OVER THE YEARS WE HAVE HAD THE REMARKABLE PRIVILEGE TO HOST TRULY OUTSTANDING SCIENTISTS FROM AROUND THE WORLD."

This year, the IMF has brought three visiting professors to Lehigh: 2015-16 Loewy Visiting Professor Alexandre Tom of the National University of Colombia, Henry Valberg of the Norwegian University of Science and Technology, and Andre Luiz Costa of the Federal University of Sergipe, Brazil. "Over the years we have had the remarkable privilege to host truly outstanding scientists from around the world," says Misiolek. On April 29, 2016, the IMF will become the Loewy Institute in recognition of the continued support of the foundation. The work of Erwin and Ludwig Loewy in England and America revolutionized airplane manufacturing through the design and construction of enormous forging and extrusion presses that changed the way fighter planes were built in war time. Later, it made way for the development of the commercial airline industry and breaking of the sound barrier. Today, the institute that soon will bear the Loewy name continues research on materials such as aluminum, copper and magnesium alloys, and so-called "soft" or "not-snake" skin. Misiolek, Tom, and Hisham Abdel-Aal of Drexel University have joined forces to analyze the characteristics of the skin of the albino python and boa constrictor. "We want to learn how nature created this skin, because we know it works so well," says Misiolek. "If we learn that, we may be able to mimic it—not copy it, but apply the same concepts to designing new material applications."