Spring 2005

Research Frontiers, Spring 2005

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UNIVERSITY OF ARKANSAS

RESEARCH FRONTIERS

SPRING 2005

Screening the Unseen

Exploring the Shape of Everyday Things

Taking the "Fight" out of Firefighting

Playing with Words

John A. White
Chancellor

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Message from the Chancellor:

In the last Research Frontiers, I shared with you the University's excitement over being named host of the Council for the Advancement of Science Writing's (CASW) 42nd annual New Horizons in Science Briefing. The University of Arkansas community was gearing up to welcome more than 100 of the best science writers from throughout the nation to Fayetteville.

The CASW conference took place Nov. 7-10, 2004, and I'm thrilled to report that it was a great success.

More than 95 percent of the CASW conference participants who responded to a follow-up survey had a favorable overall impression of the briefing, and 95 percent found the research presentations interesting and helpful.

As great as this news is, perhaps even more exciting is the overwhelmingly positive impression made by the University of Arkansas. One participant wrote, "(I) was mightily impressed with…the campus, the facilities and the scientists who presented material for us." Another wrote, "I had never visited the University before… I am left with a very favorable impression."

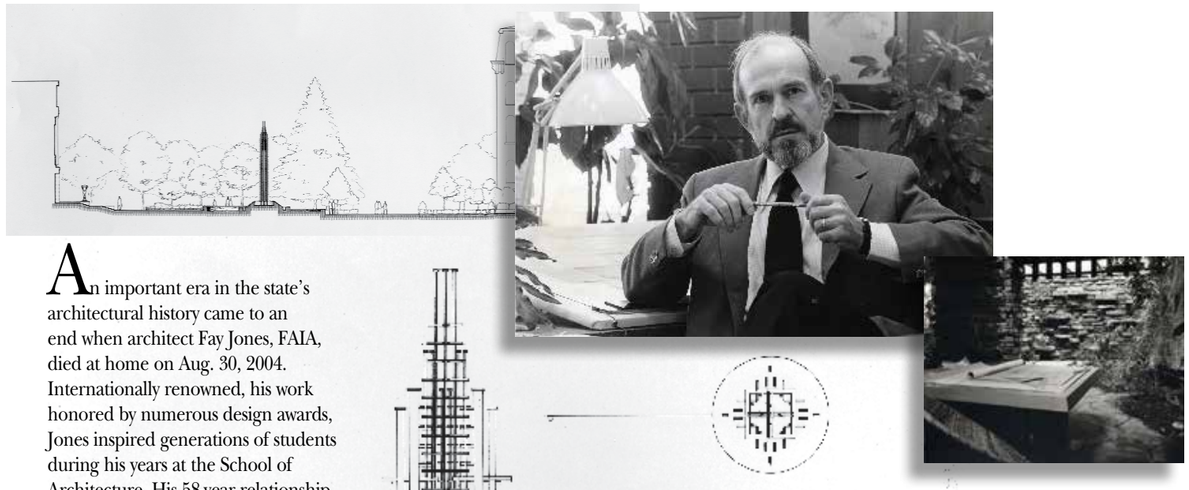
Expect to hear more about the research being conducted at the U of A in the weeks and months ahead. Many conference attendees indicated they were planning to write about presentations they saw at the briefing.

The 42nd New Horizons in Science Briefing also happened to be Ben Patrusky's final conference as executive director of CASW. He wrote that the University of Arkansas has gained many new admirers as a result of the conference, and that, "I could think of no better place and no better circumstance to cap my 30-year career as program director."

This is high praise indeed, but we in the University of Arkansas community believe it's warranted. Word is spreading about the exemplary quality of research, teaching and outreach at the University of Arkansas. I invite you to read on in this issue of Research Frontiers and see what all the talk is about.

Happy reading,

John A. White
Chancellor, University of Arkansas



An important era in the state's architectural history came to an end when architect Fay Jones, FAIA, died at home on Aug. 30, 2004. Internationally renowned, his work honored by numerous design awards, Jones inspired generations of students during his years at the School of Architecture. His 58-year relationship with the school began in 1946, when he enrolled in the first architecture classes offered at the University, and continued through 35 years of teaching and service as the school's first dean. To read more about Fay Jones' life, visit www.uark.edu/jones.html.

Jones viewed the 41-foot-tall Fulbright Peace Fountain, one of his last projects, as the "exclamation point" of his career. Located in front of Vol Walker Hall, home to the School of Architecture, Jones donated the Peace Fountain with the following thoughts on his craft:

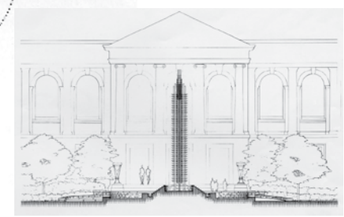
"Any work of art must contain the element of mystery and stimulate the enlargement of our vision. The search for symbolism is left to the observer. The fountain is an affirmation. It is here in this place to commemorate and celebrate the exchange program for which J. William Fulbright is known around the world.

The fountain is composed of many pieces. All parts, large and small, are integral to a harmonious and unified whole. Water provides a peaceful sound.

Light is the form delineator, creating an ever-changing array of patterns determined by time of day and seasons of the year. Images will change. It is hoped the images will leave indelible imprints on many minds.

Are we ever more human than when we respond to beauty – to beautiful words, to beautiful sounds, to beautiful images?"

Photo By Russell Cothren



Images and quotation courtesy of the Fay Jones Papers, Special Collections, University Libraries, University of Arkansas.

UNIVERSITY OF ARKANSAS
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MATHEMATICAL MUDDLES

Mathematics professor Chaim Goodman-Strauss studies the mathematical possibilities – and impossibilities – of shapes, and how these fit into everyday life. And he throws in some crocheted vegetables along the way.

FIREFIGHTER FEARS

Why do firefighters die 10 years earlier than the average man? It is not due to workplace deaths – instead, firefighters have a high risk of heart attacks. UA researchers are working with fire departments to study workplace stress and develop programs to mitigate it.

UNDER MINE

Electrical engineering professor Magda El-Shenawee and her colleagues use technology designed to detect land mines to find new, efficient, low-cost ways to detect breast cancer.

PLAYFUL PALINDROMES

Steve Chism, reference librarian at Mullins Library, likes to play with his words – so much, in fact, that he created an entire dictionary of palindromes. The Library of Congress created a new subject area just for his book and one other.

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Cover: Land mines and breast cancer are both hidden, both dangerous and both deadly. Magda El-Shenawee, professor of electrical engineering, is working with her colleagues to use technology designed to detect landmines to scour the body's interior for possible tumors.

Eyewitness Report from Refugee Camps

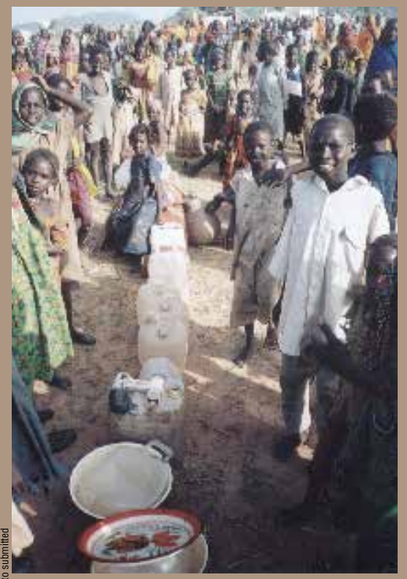


Photo submitted

In July 2004, while many listened in horror to stories about violence in Sudan, Samuel Totten, an education professor who specializes in genocide studies, joined the Darfur Atrocities Documentation Project. He spent two weeks in Goz Beida, Chad, a desert village on a dusty plain encircled by mountains and site of a camp for 13,500 refugees from Darfur, Sudan.

Totten and a co-investigator interviewed 98 randomly selected refugees. They spoke to a variety of people, young and old, men and women, many of whom had been beaten, raped or shot or had seen members of their family brutalized or slain.

He was struck by the systematic nature of the killing. Routinely, planes and bombs terrorized villagers from the air, while Sudanese military troops and Arab militias and Janjaweed attacked on the ground. He personally gathered information about five villages in a row being attacked on the same day in the same way.

Totten heard of numerous rapes by both Sudanese soldiers and Arab militia, something that recent tribunals have recognized as an act of genocide.

"Such brutality against young girls and women yet again underscores the critical need for the international community to act sooner rather than later to assist populations under attack," Totten said. "Far too often girls and women bear the brunt of vicious attacks that violate their very selfhood."

Totten identified some key findings that likely helped lead the U.S. State Department to declare that genocide had been perpetrated in Sudan. Black Africans were specifically targeted in each village, racial epithets were often used and mass rape was common. The attacks were systematic and coordinated by the Sudanese government, Arab militias and Janjaweed. Hundreds, and probably thousands, of villages were destroyed, and there was displacement of over a million individuals.

Totten emphasized the continuing need for international protection for villagers and refugees in Sudan and Chad: "It does no one any good to have a situation deemed genocide if nothing is done to stanch the killing. Each day that goes by, more and more innocent people are killed, maimed and left to starve to death or to live a life of abject misery."

In January 2005, following an investigation in Darfur, the UN concluded that genocide may not have been perpetrated, "although there may have been genocidal intent."

Totten said, "This decision, through and through, constitutes a classic case of realpolitik. The UN kowtowed to China, which has oil interests in Sudan, and to Russia, which has sold weapons to Sudan. So much for international concern about addressing genocide in an effective and just manner."

Totten, who has volunteered to take part in future investigations, is writing about his experiences for genocide studies journals and for publications aimed at policymakers. He is also collaborating on a book with Eric Markusen, a researcher from the Danish Center for Holocaust and Genocide Studies, and with another investigator with the Darfur Atrocities Documentation Project. ■

Student Cheating Not Linked to Moral Principles

Most people view cheating as a failure of moral judgment. But research by accounting professor Timothy West shows that a student's moral compass does not necessarily lead him or her away from cheating. Rather, students with high levels of moral judgment develop sophisticated ways to rationalize their cheating.

"It all comes down to how good a person is at justifying his or her behavior," said West.

West, with Sue Pickard Ravenscroft and Charles Schrader of Iowa State University, has been conducting research on cheating and moral judgment in college classrooms.

The decision to cheat stems from a variety of internal and external factors, West explained. However, one variable is nearly universal – all cheaters develop mechanisms to justify their actions.

For his research, West administered two separate tests to his students. One contained open-ended questions that allowed students to express their individual views on cheating. The other was the Defining Issues Test, one of the most commonly used tools for assessing a person's level of moral judgment, or one's ability to discern between ethical and unethical behaviors.

"I went into this study expecting to see a correlation between a person's level of moral judgment and his or her level of honesty," West explained. "After completing the study, I found that that simply isn't the case."

Surprisingly, West found that many schools' emphasis on team-building is one way that they can unwittingly foster the cheating mentality.

To prevent this, West believes that schools may have to move away from issuing so many group assignments and back toward more independent work. ■

Short Poems Suggest Chaucer Sometimes Broke Conventions of Poetry

English professor William Quinn is taking a new look at Geoffrey Chaucer's often-neglected short poems, and suggests the writer intentionally broke some of the rules he is famous for following.

"Chaucer has traditionally been seen as the single poet who determined that, for the next four centuries, we'd be counting syllables," Quinn said. "I suggest he broke the rules on purpose, and anticipated change."

The poet saw problems with absolute regularity in such poetic forms as rhyming sequences and numbers of lines in a stanza, so he experimented, and if it didn't work, he would try something else, Quinn said.

Quinn studied Chaucer's short poems, also known as lyrics. He examined composite poems, in which Chaucer experimented with different forms.

"In his short poems, he would have nine-line stanzas, then he'd have eight-line stanzas, and he'd leave out things that should've been there, like refrains," Quinn said. "You really get a strong sense of Chaucer experimenting with forms that are liberating rather than confining."

Most current research on Chaucer focuses on his ideas or themes, and includes political or gender readings, Quinn explained. By looking at the nuts and bolts of the poetry, and how Chaucer constructed his verse, he hopes to determine what the poet's design strategies were.

"Was it meant to be sung or recited? If it was to be recited, was it meant to be done so publicly or privately?" Quinn said.

By looking at the words used in the poems, Quinn tries to determine whether Chaucer was addressing one person intimately, a group of people, or one person more formally. He asks himself how that affects the number of lines Chaucer put per stanza.

He has unearthed more questions than answers as he examines what he calls a shaky body of evidence on Chaucer's lyrics.

"It's amazing how very little has been written about Chaucer's short poems," Quinn said. "He's second only to Shakespeare in the amount of stuff written about him, but it's mostly about his narratives." ■

Here's the Buzz: A New Hornet Darkens Arkansas' Horizon

Photo submitted

As if Arkansas didn't have enough insects already, a large, imported hornet recently moved into the state.

The European hornet has begun breeding in the Arkansas Ozarks, said Jeff Barnes, curator of the University of Arkansas Arthropod Museum.

Barnes, a taxonomist for the U of A Division of Agriculture, said many callers are alarmed by the hornet's robust size and sometimes distressing behavior. With females up to nearly 1.5 inches long, it dwarfs the common Arkansas yellowjacket.

Although not aggressive, they will defend the colony with painful stings when a nest is threatened. Barnes said one study showed that allergic individuals have three times the risk of having a dangerous allergic reaction to a European hornet sting than they would have from a honeybee or yellowjacket sting.

The hornet normally flies during daylight, but in humid, windless weather, workers may fly at night and are attracted to windows of lighted homes, Barnes said.

"We've had reports of European hornets beating themselves against lighted windows with impressive and frightening force," he said. "One lady described the hornets, attracted by a light outside her garage, as hitting the windshield of her car like a hail storm."

The European hornet arrived in North America in New York in the mid-1800s. It crossed the Mississippi River into Missouri in the 1980s. It was identified in Arkansas in 1999, with a specimen collected from a nest in Harrison, Barnes said. Since then, specimens have been collected from Carroll and Washington counties.

"I've seen sufficient specimens and gotten enough calls to believe the species has become pretty well established in Arkansas," he said.

It prefers forest environments to urban or suburban areas and the hornet's contact with humans is usually low, Barnes said. But contact may increase with the growth of new homes in wooded areas of Northwest Arkansas. ■

Researchers Discover Additional Mechanism That Regulates Protein Activity

Roger Koeppe, University Professor of chemistry and biochemistry, and his colleagues have discovered a new mechanism that regulates the interaction of proteins in cell membranes. This discovery may lead to more efficient drug screening and possibly different methods for fighting infections.

The researchers reported their findings in the journal Nature.

Scientists have explained the interaction of antibiotics using a "lock and key" model, where a small drug of a certain shape (the key) binds to a bacterial protein (the lock) to neutralize it and prevent the spread of an infection.

In the Nature paper, the researchers show that this model is not the only rule in drug-protein interaction. They discovered that the mirror image of a peptide isolated from tarantula venom had the same effect on a certain type of pressure-sensitive cell membrane protein channel as did the natural peptide toxin – a finding that violates the "lock and key" model because the toxin and its mirror image have different shapes.

Further, they found that the mirror images of bacterial gramicidin channels, developed in the Koeppe laboratory, respond much like natural gramicidin channels to both the tarantula toxin and its mirror image. "The effect is similar in different chemical systems," Koeppe said. The researchers have concluded that, instead of working by the traditional "lock and key" model, the peptide toxin and its mirror image change the shape or curvature of the lipid bilayer, or the protective "skin" of the cell membrane.

This finding opens up a host of new applications, including the possibility of using mirror-image proteins for drug therapies. Often, the mirror-image peptides or proteins are biologically more stable and, if developed into drugs, could last longer in the body, Koeppe said. Also, the mirror-image proteins don't activate the body's immune system as effectively, which could have a positive impact on organ transplant acceptance.

The gramicidin channel system also could be used to screen the generalized effects of potential drugs on the mechanical properties of lipid bilayer membranes.

"If new drugs could be tested on gramicidin channels, it could speed up predictions of what such drugs would do in other systems," Koeppe said. "This could help companies find out early if there is a problem instead of investing three years and then finding out." ■

Science Writers in the Field

About 100 science writers from all over the country visited the University of Arkansas in the fall to hear about the latest cutting-edge research on campus and around the nation at the 42nd New Horizons Briefing put on by the Council for the Advancement of Science Writing. During that time, they took a field trip to the Ozark Mountains, where entomologist Fred Stephen talked to them about the red oak borer, an insect that threatens trees in the Arkansas and Missouri Ozarks and represents a rare case in which an indigenous insect threatens to destroy its native ecosystem.

The writers also participated in an international search for slime molds, funded by a National Science Foundation biodiversity grant, to search for and characterize slime molds all over the world. Led by biological sciences professors, Fred Spiegel and Steve Stephenson, the group scoured the forest floor and the leaf canopy and discovered about 36 different species of slime molds.

Other campus researchers who gave lectures include Peter Ungar, anthropology; Laurent Bellaiche, physics; Donald Judges, law; Brent Smith, sociology; Jean-Francois Meullenet, food science; and Jerry Havens and Tom Spicer, chemical engineering. ■

CASW
Forty-Second Annual Briefing
NEW HORIZONS IN SCIENCE

Photos By Russell Cothren

'Ambassador' Unites Diverse Disciplines, Unique Research Capabilities

A well-traveled, multidisciplinary ambassador is helping scientists see things they've never seen before. This ambassador, known as HARLS-CS, is an integrated suite of high-tech equipment that offers mapping and modeling capabilities unavailable at any other U.S. research institution.

The High Accuracy/Resolution Landscape and Structure Characterization System expands research activities in fields as diverse as crop health study, urban planning and homeland security.

"Suppose someone released aerosol with anthrax," said Fred Limp, the director of the Center for Advanced Spatial Technologies (CAST). "Where will it go? What will it do? In order to predict its movement it is necessary to have accurate three-dimensional maps of all buildings, trees and the landscape. With the HARLS-CS now we can actually map an entire city in 3-D."

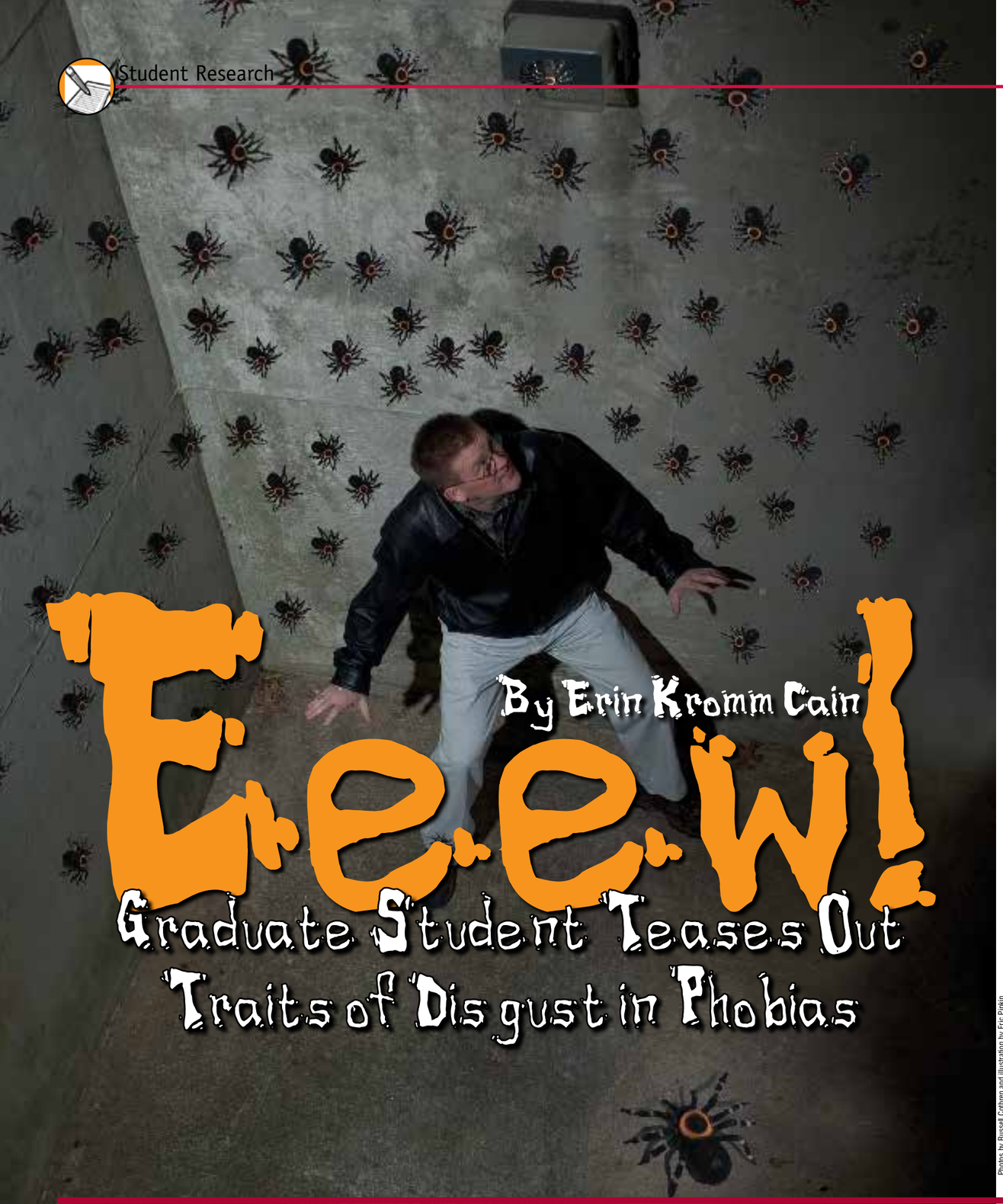
HARLS-CS allows researchers to quickly and accurately measure landscape and building-sized objects and create precise three-dimensional representations. This fits with technology already available at CAST, which is used for large-scale applications such as fields and lakes, or small-scale applications, such as characterization of teeth.

"In the past year, HARLS-CS has really been places," said project coordinator Jackson Cothren, an assistant professor of geosciences. The travelogue includes several archeological surveys, such as American Indian burial and ceremonial mounds in Spiro, Okla., and the study of remnants of a World War I era "army city" outside Fort Riley, Kan.

The HARLS-CS is currently being used by 13 faculty and students in CAST, the Archeological Survey, the Archeo-Imaging Lab and departments of anthropology, architecture, biological sciences, biological and agricultural engineering, civil engineering, entomology, geosciences and environmental dynamics.

The HARLS-CS suite contains a laser profiler, field spectroradiometer, multispectral camera, digital cameras, GPS, supporting software and a towable lift boom. Cothren brings together this diverse equipment to create a comprehensive way of looking at problems in need of resolution. ■

Photos submitted



E.e.e.w!

Graduate Student Teases Out Traits of Disgust in Phobias

By Erin Kromm Cain

Photos by Russell Cothren and illustration by Eric Pipkin

Graduate student Bunmi O. Olatunji delights in showing people pictures of creepy-crawly creatures, rotting food and gaping wounds, just to get a response out of them – all in the name of research.

"It is a pretty good deal that you can study disgust and call it science," he said.

The 27-year-old studies anxiety disorders, in particular the role of disgust in phobias and contamination-related obsessive-compulsive disorder (OCD). His research has been published in numerous journals, including the Journal of Social and Clinical Psychology, the Journal of Anxiety Disorders, and Behaviour Research and Therapy.

One of Olatunji's studies shows that disgust is a more complex phenomenon than previously believed. His paper studied the structure of disgust and examined whether it is a one-dimensional or multidimensional construct.

"The one-dimensional theory would suggest that all disgust stimuli are the same or connected in some fashion," Olatunji said. "However, a multidimensional approach would suggest that certain categories of disgust elicitors, such as injections and blood draws, are qualitatively different from other categories of disgust, such as small animals and rotting foods. We tested the theories against each other and the one-dimensional theory didn't fit the data well."

The two-dimensional model divided the emotion of disgust into two basic categories: core disgust and animal reminder disgust. Core disgust is triggered by stimuli that may be offensive, such as rotting foods, waste products and small animals. It may be the basis for obsessive-compulsive behavior triggered by improbable contamination fears.

Animal reminder disgust includes aversion towards stimuli that remind us of our animal origins – things such as death, skin or body violations, such as injections, blood draws, or mutilation, hygiene concerns and sexual acts deemed inappropriate.

The two-dimensional model revealed that core disgust is more highly correlated to contamination fears than animal reminder disgust. The findings may help clinicians better treat patients. Among the most common phobia therapies is a technique called exposure treatment, in which patients are exposed to the object of their phobia to overcome their fear of it. The results of Olatunji's research indicate that this treatment may need modification to accommodate both types of disgust.

Olatunji also conducted research comparing the relationship between the two types of disgust and fainting. He found that animal reminder disgust predicted blood-injection-injury phobia and fainting. These fears are unique because avoiding the cause of those fears can be detrimental to a person's health.

"People become very efficient in avoiding their fears," Olatunji said. "When their fear is caused by needles or blood draws, this can keep them away from necessary medical care."

Ironically, phobias are one of the easiest psychological problems to treat, but people rarely seek clinical help because they simply avoid the cause of their fears, he said.

Much of Olatunji's research involves exposing people to these types of stimuli, and having them indicate on a questionnaire how the stimuli affect them. Sometimes he uses pictures, but other times he has the compelling task of finding some pretty disgusting things. Going to the store for supplies can be interesting.

"When you buy cow eyeballs, bedpans, urns, worms, white underwear and pudding, people tend to give you strange looks," he said. "And it's hard to convince them that it's for science!"

Olatunji was born in Nigeria and moved to the United States in 1985. He studied clinical psychology at University of Wisconsin-Stevens Point, where he served as research coordinator for the Pain Tolerance Research Laboratory and was a research assistant in the Social Cognition Research Laboratory under his mentor Hamid Hekmat. He graduated in 2000 with distinction.

The same year, he moved to Arkansas and began his graduate research training when he assumed full responsibility for the operations of the Anxiety Disorders Research Laboratory directed by psychology professor Jeff Lohr.

"I wanted to work with Dr. Lohr, and it just so happened that he was in Arkansas," Olatunji explained.

Bunmi O. Olatunji

Olatunji developed an interest in the origins of anxiety and factors that sustain anxiety disorders through his work in Lohr's lab. He currently is interested in the role of disgust in the development of specific phobias, such as blood-injection-injury phobias, and contamination-related OCD, such as excessive hand-washing.

In 2003, Olatunji was awarded the National Institute of Mental Health National Research Service Award fellowship in the amount of $57,000. In 2004, he was appointed to the editorial board of the Journal of Anxiety Disorders; the second graduate student to ever hold that position. His predecessor was appointed while at Yale.

Olatunji is proud of his many collaborations and the contributions he has made to the scientific literature. He plans to extend his research on anxiety-related psychopathology to other disorders in hopes that this may facilitate the development of more disorder-specific interventions. He is preparing to begin a clinical internship this summer at Harvard University.

Lohr said there will be a large hole in his academic life when Olatunji leaves to continue his endeavors.

"Bunmi has become a superb scholar and clinician. He has developed from a bright-eyed graduate student to a valued and trusted colleague. He is great fun to work with because of his intellect, interpersonal charm, and a wonderful sense of humor," Lohr said. "He has a great professional career in front of him, and I am intensely proud to see him get on with it." ■

The Shape of Everyday Things

By Melissa Lutz Blouin
Images by Chaim Goodman-Strauss
Photos by Russell Cothren

Mathematics professor Chaim Goodman-Strauss' earliest memories are laced with a fascination with patterns.

Stones in streams, designs on walls, lines on sidewalks, leaves on grass – he found himself drawn to these things not only for their visual beauty, but because they made him wonder.

He wondered how patterns form, how tree branches grow in a certain way, and how leaves grow in certain shapes.

As a teenager, he heard a lecture on the mathematician Georg Cantor, who gave a simple, clear way to compare the sizes of infinite sets: some infinities are the same, but some are larger than others. Amazingly, the size of the set of counting numbers is the same as the size of all fractions,

Above, Mathematician Chaim Goodman-Strauss finds himself drawn to patterns such as this tiling in which all the tiles are exactly the same shape, but are different sizes. This particular tile can tile in a rich fashion, but little is known about tiles such as these. **Right,** This is an example of hyperbolic geometry. The patterns where triangles meet in sixes can be found in the plane (see small circle), while patterns where triangles meet in fives, fours and threes represent the spherical shape. Patterns of triangles that meet in sevens or greater represent the hyperbolic plane (see large circle). Here, the triangles have been distorted in a particular way to draw in the plane, just as Earth is drawn in a distorted fashion when illustrated on a flat map.

because there is a one-for-one correspondence between counting numbers and fractions.

Even more amazingly, though, Cantor showed the set of real numbers is vastly larger than either the set of counting numbers or fractions.

For Goodman-Strauss, this lecture multiplied his interest in the intersection of logic and geometry – mathematics – and added up to a future career.

"I was already doomed to be a mathematician, but that lecture sealed my fate," he said.

Today, Goodman-Strauss finds himself drawn to paradoxes. Take the statement: "This sentence is false." A moment's thought shows the statement can be neither true nor false: either option would lead to a contradiction.

Such paradoxes also exist in mathematics. In 1931, Kurt Gödel, one of the greatest logicians of the 20th century, proved that any set of mathematical rules is either incomplete, in the sense that they miss important truths, or inconsistent, in the sense that they contain a contradiction.

"Gödel used mathematics to demonstrate its own limitations," said Goodman-Strauss. "The paradox of this really drew me into mathematics."

He studies topology, or the mathematical description of structure. Topologists study the properties of geometrical structures, including connections between them. Consider, for instance, a New York subway map. The map does not tell you how far it is from central Manhattan to the Bronx, or whether one station is north or south of another, but it does show you how the stations connect to one another.

"Topology can describe everything from the chaos in weather to the development of a baby's ear," Goodman-Strauss said.

Topologists study spatial objects, including curves, surfaces and even the space we call the universe.

Topologists investigate properties of shapes that are preserved even as the shapes are deformed, twisted or stretched. For instance, you can stretch a circle and crea an ellipse, but the new shape will retain some of the circ topological qualities. Mathematicians have a joke that su this up:

"Question: What is a topologist? Answer: Someone wh cannot distinguish between a donut and a coffee cup."

Humor aside, the strength and weakness of mathemat ics, Goodman-Strauss believes, is that it creates new ways thinking about things. This can lead to important insigh or it can lead to abstractions that have little to do with th real world.

"It can be difficult even for scientists to appreciate where mathematicians live," he said.

One glance around Goodman-Strauss' office offers an eyeful of how he lives. His walls sport posters filled with colorful geometric tilings. His shelves hold books, but also three-dimensional shapes in wood, paper and other media. The office window is covered in paper snowflakes. The ceiling sports images of spherical repeating patterns, some of which will be featured in a book about symmetry that he is writing with John H. Conway of Princeton University. Shapes composed of balls and sticks perch on filing cabinets.

He reaches up to the top of one of the filing cabinets and pulls down a wooden object with an unusual shape – almost conical, yet spherical as well. It is a representation of hyperbolic geometry.

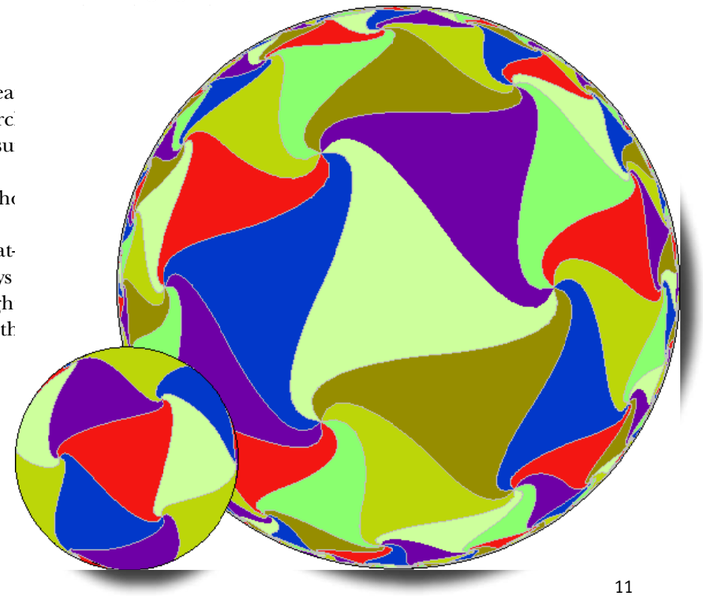
"You can look inside your refrigerator and find a piece of hyperbolic space," he said.

The next time you make a salad, pull the leaf lettuce out of the vegetable crisper. The wrinkled, crinkly leaf lettuce has lots of area in a small space. "Anything that's super frilly has the same geometry as the hyperbolic plane," he said.

Goodman-Strauss is curious about the way living things take form. He continually finds himself fascinated by the structure of trees and the patterns the branches follow as they grow. He points out that while biology and mathematics have made great inroads at the molecular and ecological level, little is known about the geometry and form of living things or why living things take on the shapes they have.

Which may explain why Goodman-Strauss ended up using his grandmother's crocheted fruits and vegetables during a mathematics research lecture at Brigham Young University last year.

In crocheting, a person uses different numbers and types of stitches to create shapes. You can see the stitch patterns in the colorful creations that Goodman-Strauss has piled up on his table – strawberries, carrots, pineapple and cauliflower. They offer a mathematical model for explaining the challenging concepts of



Using a visual aid enhances his teaching, which informs his research – and vice versa.

"I try to foster a sense of exploration in the classroom," he said. "And I think I'm a stronger researcher because I think about how I can ground mathematics in the reality around us."

Many people shy away from mathematics, but math continues to be important in everyday life, Goodman-Strauss said. People use math to assess risks, invest for the future, count calories, and decide on the better bargain when they make decisions.

Often, people's aversion to math has to do with the way they learn it.

"When people come out of high school, they know the techniques, but they often don't know what the math means," Goodman-Strauss said.

Scale, rates, statistics, probabilities and risk factor into decisions people make every day. Yet people often don't realize that basic math can help them make better-informed decisions.

"We're always making calculations and judgments about things," Goodman-Strauss said. One needs only to pick up a newspaper to see examples. Medical studies on diet, the federal budget, the national debt, the gross domestic product, Social Security – all of these involve mathematics, and all of them impact the everyday lives of people, yet people often have no concept of how to interpret the data they see.

"Quantitative illiteracy affects public policy and society at large," Goodman-Strauss said. "The mathematics department has the potential to be a leader in teaching people critical thinking skills."

To help address these issues, the mathematics department has developed a set of innovative finite math sections, and Goodman-Strauss is teaching one of those sections. One day he used the nuclear arsenal of the United States as an example to explain scale to his students and to emphasize the message that mathematics matters. A few simple calculations that add the zeros on the end and multiplying by two to approximate the conversion from tons to pounds tells you that a one-megaton bomb contains about the equivalent of 2 billion pounds of dynamite. The U.S. arsenal has about 10,000 bombs.

"It's not a bad guess that they're about one megaton on average" said Goodman-Strauss. If the world population is about 6 billion people, that means the U.S. arsenal contains the equivalent of about 3,000 pounds of dynamite for every person on Earth.

"That is an astonishing use of numbers!" Goodman-Strauss said.

In addition to bringing pertinent information about mathematics into the classroom, Goodman-Strauss has taken mathematics outside the classroom. He coaches bright students for the Putnam Exam, a mathematics exam given annually that stymies all but the nation's brightest mathematical minds. He serves as adviser for the math club. And recently he created a Math Problem of the Week series that runs on Ozarks at Large, the local news program on National Public Radio, KUAF 91.3 FM, at 9:30 a.m. Sundays.

This year, he is sponsoring the second Bamboopalooza, an event where people will use bamboo poles to create a giant geometric shape.

"There's a lot of math behind it," Goodman-Strauss said, but the participants won't delve deep into the calculations that lie beneath the creation. "It's really just suggesting that there's this other, mathematical world."

That mathematical world fascinates Goodman-Strauss, and he spends lots of time navigating a particular area of geometry called tiling. He studies the complex behavior of repeating shapes and how they fit together. The shapes could represent bits of computer code, mathematical equations or molecules.

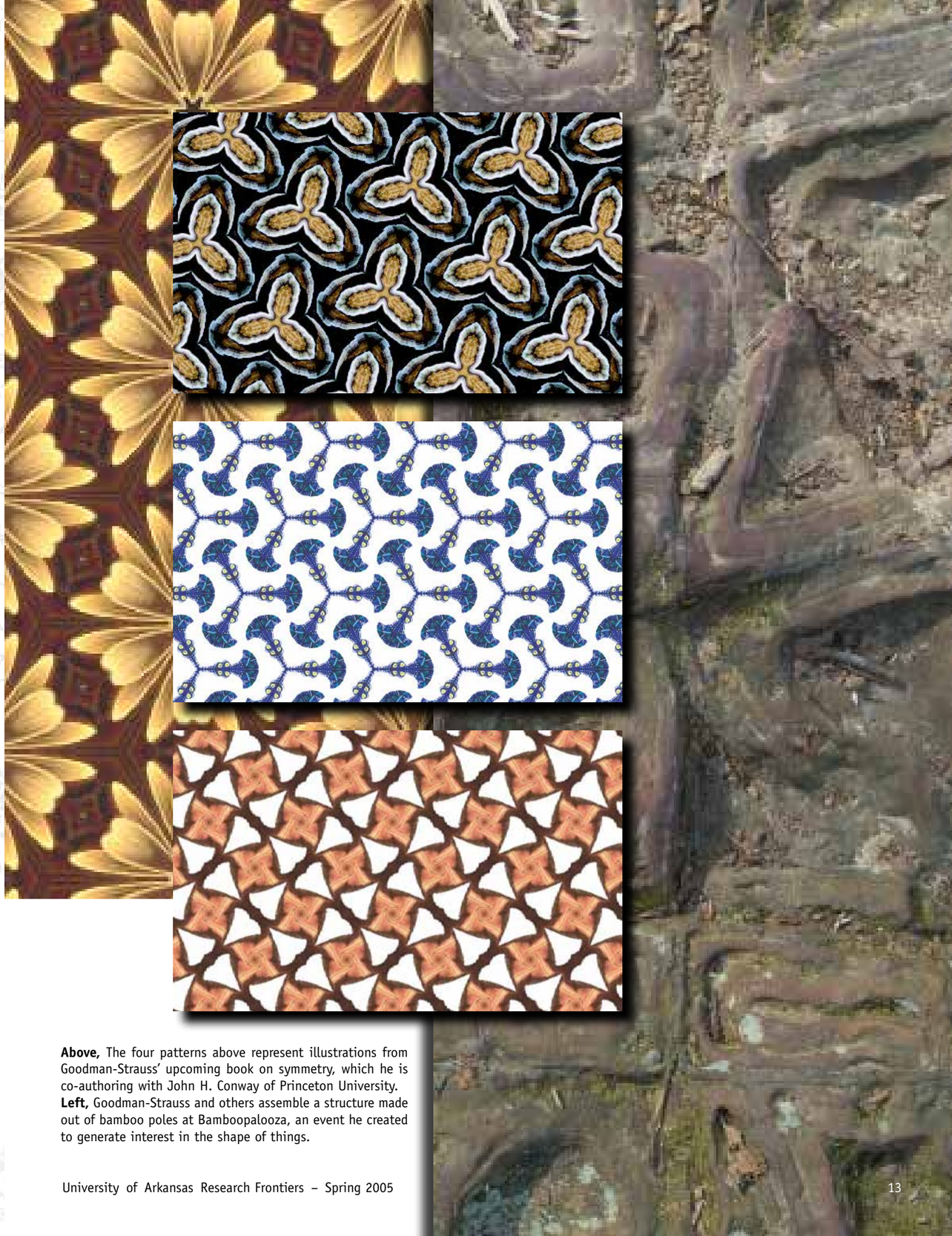
In particular, he studies "aperiodic" tiles; you can fit copies of aperiodic tiles together to make a tiling, but only in non-repeating patterns (see illustration on page 14). For example, black and white squares are not aperiodic: you can fit together black and white squares to make a non-repeating pattern, but you also can fit them together to make a repeating pattern. Aperiodic tiles can only make non-repeating patterns.

Mathematicians have only been aware of such tiles since the 1960s, and only a handful of such patterns had been discovered up to the mid-1990s.

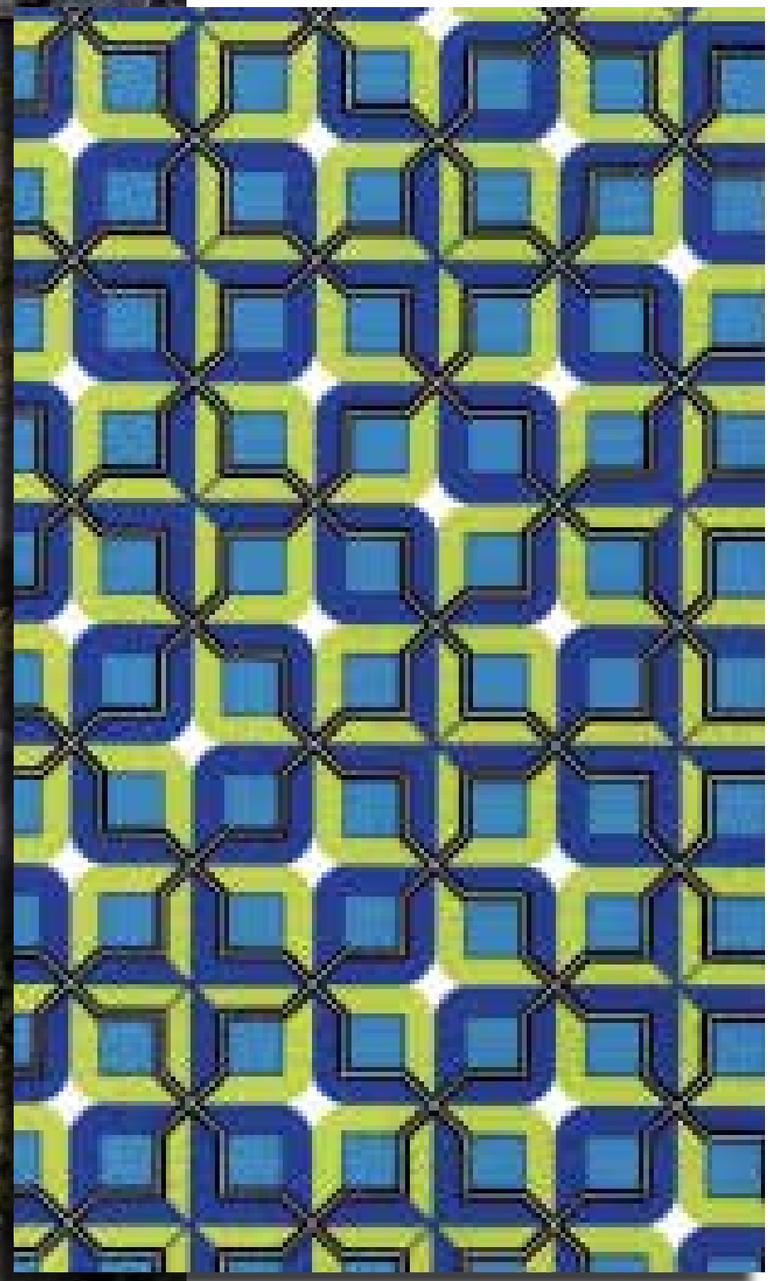
"There was no rhyme or reason to why they worked," said Goodman-Strauss.

But in 1995, Goodman-Strauss created a very general method for creating new aperiodic tiles. Before this, only a dozen examples were known; his method gave infinitely many. The technique even works in every higher dimension.

"The really amazing thing," says Goodman-Strauss, "is that aperiodic tilings are related to Gödel's theorem and the concept of undecidability."



Above, The four patterns above represent illustrations from Goodman-Strauss' upcoming book on symmetry, which he is co-authoring with John H. Conway of Princeton University.
Left, Goodman-Strauss and others assemble a structure made out of bamboo poles at Bamboopalooza, an event he created to generate interest in the shape of things.



Above, Another example of what Goodman-Strauss studies: An aperiodic pair of tiles that fit together to cover the plane, but not in a way that ever quite repeats. **Right,** a sampling of math cards "produced by the world's foremost fictional math trading card company, the Ptolemy Math Card Company," jokes Goodman-Strauss. He creates the cards, which have mathematical explanations on the reverse side.

A renowned mathematician of the early 20th century, Alan Turing, proved that there are certain mathematical questions for which there can be no general method of answering. The Halting Problem is the most famous example: there is no general procedure to decide whether a given computer program will or will not halt after a finite number of steps. The question is undecidable. Certain tiling problems are also undecidable, such as the Domino Problem, which asks if given a set of tiles, can you decide if they can tile the entire plane at all.

Goodman-Strauss used the Domino Problem in the first proof of an aperiodic set of tiles in the hyperbolic plane – work that was supported by the National Science Foundation and appeared in the prestigious journal Inventiones Mathematicae.

Goodman-Strauss continues to contemplate these and other mathematical problems.

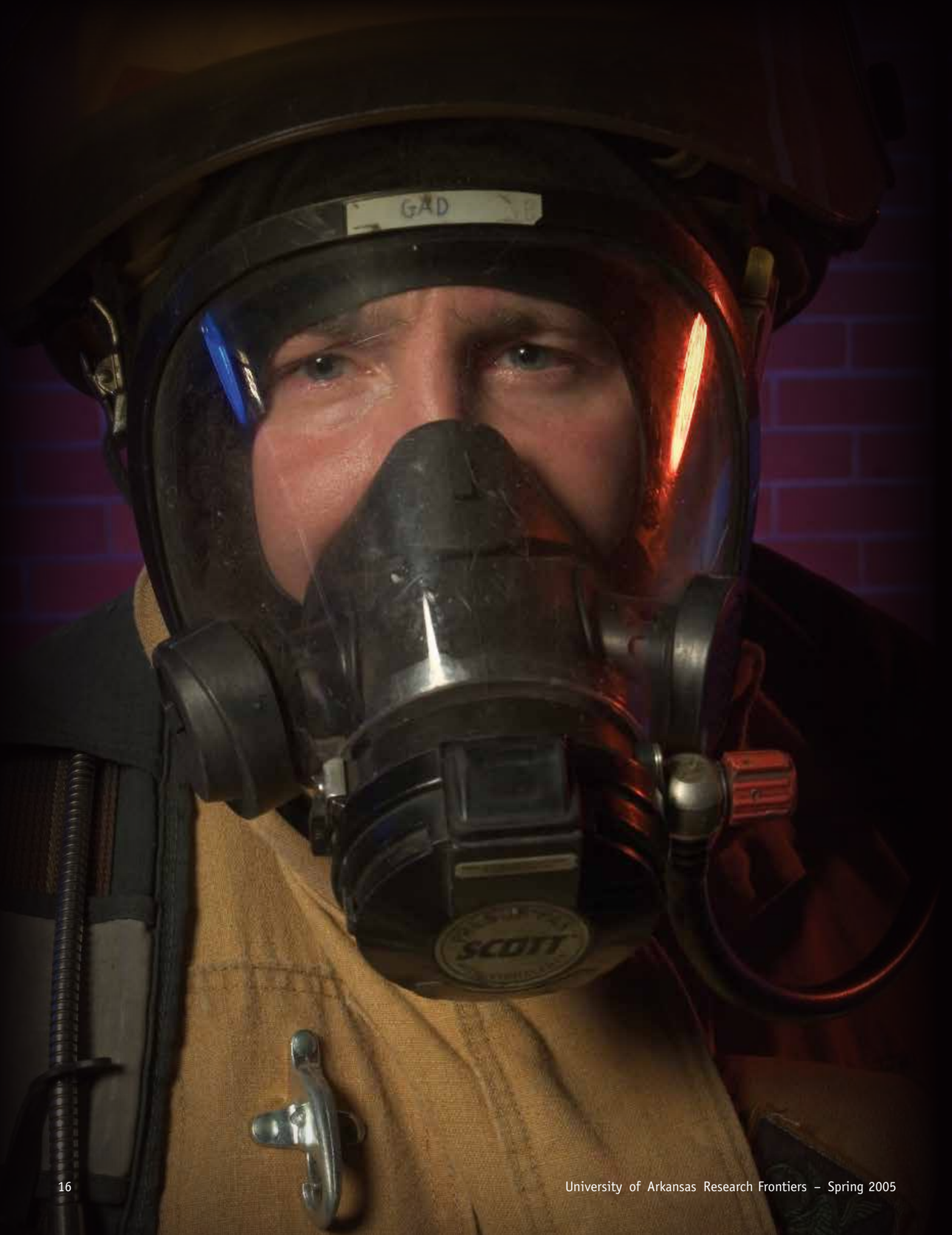
"The great thing about Gödel's theorem," said Goodman-Strauss, "is that it proves mathematicians will never know all of mathematics. That's what I call job security!" ■

The Hilbert Hotel

Chaim Goodman-Strauss has always been fascinated with infinity, a topic that he has talked about on KUAF public radio with Ozarks at Large host Kyle Kellams. The German mathematician David Hilbert's hotel analogy that helps explain the concept of infinity:

When a hotel with a finite number of rooms fills up, there is no room left for another guest. However, at the Hilbert Hotel, which has an infinite number of rooms, you can always fit in another guest.

That's because at the Hilbert Hotel, you can simply move guest 1 into room 2, guest 2 into room 3, etc., without end, thus accommodating one more guest. And another and another and another…infinitely! ■



By Barbara Jaquish

TRAINING FIREFIGHTERS *to Live Longer*

Bud Thompson returned from training at the Cooper Aerobic Clinic in Dallas with a troubling question: Why are men who work as firefighters likely to die 10 years earlier than the average man?

As a battalion chief in the Fayetteville Fire Department, he was well aware of the physical demands of his profession, but in Dallas he had learned that the male firefighters on his crews are prone to premature death.

The data that produced this dismal prognosis didn't include the work-related injuries that led to death. Nationally, the number one cause of death for firefighters is heart attack, and occupational stress is a recognized risk factor for heart disease.

Thompson sat down with professor Barry Brown to discuss what he had learned and asked him what he could do about his firefighters' increased risk of heart disease.

Brown, a University Professor of exercise science with 35 years of experience in fitness testing and exercise prescription, learned that the stress firefighters face is unlike the everyday stress of most working people.

"On top of the incredible physical demands, firefighters know that an alarm may sound at any moment, requiring them to perform at maximum capacity to save lives," he said.

In Thompson's question, Brown saw an opportunity to apply his experience in reducing stress and enhancing athletic prowess to the life-and-death performance demanded of firefighters. As a teacher, he also saw an opportunity to engage his undergraduate and graduate students in a challenging and meaningful project.

Thompson's simple question, combined with the expertise and dedication of a team of UA faculty and students, grew into a research and service project that has the potential to improve the lives of firefighters throughout the United States.

Pilot Program

In the months after talking to Thompson, Brown and his graduate students conducted an initial study in spring 2003 with 21 volunteers from the Fayetteville Fire Department. They recognized that the physical demands of a firefighter's job are similar to those of many sports – strength, flexibility, endurance and power – and developed a training program to improve these attributes.

Brown knew from his experience with athletes that, while genes determine much of human physical capability, people can improve their fitness measures by up to 40 percent with a carefully planned program.

"In just five weeks of the pilot project, we saw dramatic improvements in endurance and stamina," Brown said. "When we compared test results from the beginning and the end of the program, we saw that these firefighters were able to achieve improvement in fitness that is usually seen after 12 to 16 weeks of training."

Based on this initial study, the Federal Emergency Management Agency provided $105,000 to fund a year-long training program for the entire Fayetteville Fire Department.

Researching Strength and Power

To conduct the testing and training of more than 60 firefighters, Brown relied on a team of graduate students – Koulla Parpa, Leigh Jurney and Marcos Michaelides – and the participation of undergraduates in an exercise science class.

The research team started with a physical fitness questionnaire administered to all firefighters to screen for those who needed further testing or a medical examination and to identify those psychologically ready. The researchers used Prochaska's five stages of change, a system for determining readiness to change that has been used in treating tobacco addiction, to assess the firefighters' awareness of and commitment to a potential fitness program.

Prochaska's system divides the change continuum into stages designated as pre-contemplation, contemplation, preparation, action and maintenance. As the program progressed, the researchers guided firefighters in moving from the pre-contemplation level of awareness of a problem without a plan for change, or the contemplation level of thinking about change, to an action mode involving considerable commitment of time and energy.

The research team designed a three-month program of strength and power training involving monitoring of the firefighters as they engaged in regular vigorous exercise and conditioning.

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o learn whether specific weight-
tioning combined with informa-
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dence of stress in firefighters.

Building Trust

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Photos by Russell Cothren

After only a couple of weeks, the first group of firefighters began to notice results. With that, Michaelides said, they wanted to come into the gym more often than required, and Parpa found that these firefighters began to influence the rest of their co-workers to embrace the program. They began calling Jurney to confirm the next training session.

Michaelides, who has lifted weights for over seven years, admitted it took him some time before he looked forward to working out. He was impressed with the firefighters' commitment – no one skipped a session, and they always arrived on time.

"I was amazed at how much improvement they made and how fast we saw changes in their bodies," he said. "And after the study, they kept going on. No one wanted to stop. Everyone felt much better, and they were asking for trainers."

Brown describes the rapport the firefighters developed with the students as being similar to an athlete and coach relationship. Firefighters have expressed disappointment when student trainers graduate and leave the program. When Parpa and Michaelides visited their families in Cyprus, firefighters were concerned about their progress, because an important part of their motivation was on the other side of the world.

At the end of the three-month research and training program, firefighter Jerry Kelly discussed his participation. He noted that as the city of Fayetteville grows, so does the size of new buildings, which increases the physical stress of an already stressful job. Although he has always worked on being physically fit, he was able to increase his time on the step mill stress test by two minutes in his first three months of training.

Joe Scheyder, captain of Fire Station 2, described himself as the oldest person in the group. It had been years since he had worked out, and after three months, he had "a huge increase" in strength and stamina. When he promoted the program to his crew, they all signed on. There was a lot of interest in his fire station in the new equipment, treadmills and weights.

"This program is state-of-the-art as far as the country goes, not to mention the state of Arkansas," Scheyder said.

Studying Stress

Michaelides learned first-hand about the routine stress firefighters face when he participated in a training exercise that involved entering a burning building. He put on the suit, hooked 60 pounds of equipment onto his body, and went inside, where it was so hot that his helmet began to melt.

"You can't imagine how hard it is," he said. "There's the heat – it can get to 400 degrees or higher – plus you must be strong to carry the gear and hold the hose. It takes three men just to hold the hose."

During that training session, researchers measured the heart rates of the firefighters. All were alarmingly high. The heart rate for one, who had just left the burning building, tested at 200 beats per minute. It is this level of stress, coupled with the uncertainty of when they will have to perform, that some researchers have suggested as an explanation for the premature death rates of firefighters.

After analyzing the assessments, the researchers divided the firefighters into three groups, one for strength and conditioning, another for power-training and the third as a control group that could continue whatever they had been doing. All groups were tested to determine the maximum weight each one could lift. The strength-training group worked out at 70-80 percent of maximum, using lighter weights and more repetitions than the power-training group. For the power-training group, the weights were increased to 85-95 percent of maximum with fewer repetitions.

Photos submitted

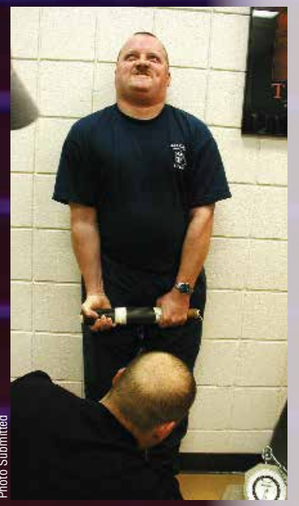


Photo Submitted

It was difficult to maintain a true control group, however, since half-way through the program, firefighters in the control group saw the changes in their co-workers and began to increase their own workouts and activity levels.

The wellness component included presentations by exercise science undergraduate students about stress reduction, risk factors for heart disease, and obesity and eating habits. Jerald Foote, assistant professor of nutrition, provided individual counseling to develop nutritional programs aimed at enhancing performance. Ed Mink, director for health promotion with the University Health Center, talked with the firefighters about strategies for handling stress.

Stressed-out Spit

Some of the preliminary results were what Brown and Jurney expected. For example, they looked at the resting blood pressure rate and the level of oxygen used at maximum effort – known as the VO_2 max level – that was measured during a stair-climbing test. For those whose resting systolic blood pressure rates were lower, the VO_2 max levels were higher, indicating that the training had effectively increased the capacity for exercise with less stress on the body. They also saw overall increases in strength in tests of the lat pull, the bench press and the leg press. Body fat levels had decreased.

Preliminary results also showed something unexpected: there was a significant difference in the firefighters' response to physical and emotional stress.

To understand firefighters' stressors, Brown and Jurney measured cortisol levels present in saliva that was collected at various times during the day. Cortisol is a steroid hormone produced by the adrenal glands that helps regulate blood pressure and cardiovascular function, as well as the body's use of carbohydrates, proteins and fats. Cortisol secretion increases with any stress to the body – either psychological or physical, such as an injury, illness or exposure to extreme conditions.

The researchers collected saliva samples each morning and night for baseline levels, then collected again when firefighters were at rest, immediately before they left the station on a run and immediately after they fought a fire. The researchers then tested the cortisol levels present in the saliva to determine if the firefighters were experiencing chronic continuous stress and what effect the training was having on stress levels.

All firefighters, experienced and rookies, showed elevated cortisol levels after the physically challenging stair-climbing test. For this test they wore 60 pounds of gear and a bulky, fire-retardant suit and, as typically competitive individuals, pushed themselves to continue climbing almost to the point of collapse. After the test, cortisol levels were high for all firefighters, experienced and rookie.

But, results were different in the firehouse after an actual run. In this case, the cortisol levels soared higher for rookies than for experienced firefighters. Brown believes the difference is an indication of emotional stress. While all face the same physical stress while fighting the fire, experienced firefighters seem to have a better idea of what to expect when the alarm sounds and the trucks roll.

Brown and Jurney believe that the stair-climbing test they used is relevant to the particular physical demands made on firefighters and thus can isolate physical stress response. They suggested that further research is needed, particularly with rookie firefighters, to examine factors involved with emotional stress. Brown also noted that recent research has examined the effects of inflammation on heart disease, which suggests that testing for C-reactive protein (CRP) to measure the level of inflammation in the body might yield valuable information.

Maintenance

After completing the first three months of research that assigned firefighters to groups, Parpa is working with exercise science student trainers to develop individualized training programs for each Fayetteville firefighter. They hope to match fitness plans with individual interests to encourage long-term maintenance of exercise habits. She is emphasizing aerobics with some weight training, particularly for those firefighters who need to lose some weight before taking up vigorous strength or power training.

The trainers will work with firefighters so they can perform testing on their own as they work out. To measure body fat, they can use new equipment provided in the fire stations that is similar to the body fat analyzers used by the university researchers. They also will begin logging sit-ups and push-ups, tests that aren't useful in research but can give a picture of progress and aid in motivation.

Taking it to Arkansas and the World

Brown hopes that when FEMA and local governments see the impact of the Fayetteville Firefighters Wellness Program, they will fund an ongoing program for firefighters. Brown envisions a National Firefighters Life Improvement Center serving mid-sized fire departments nationwide.

As a step toward this goal, the university and the Fayetteville Fire Department presented the first Firefighters Professional Wellness Certification Workshop in February 2005. They brought together firefighters from Arkansas, Missouri and Oklahoma to learn strategies to reverse premature death and illness from cardio-vascular diseases and to enhance performance and morale.

After passing written and practical examinations, the 18 participants earned continuing education credits from the UA Center for Corporate and Employee Wellness and the American College of Sports Medicine. They are certified to conduct health and fitness programs in their hometown fire departments, and will receive periodic newsletters to assist them. Several firefighters from the Fayetteville Fire Department were certified, and Parpa will be working with them through December 2005 as they begin training their co-workers.

Brown presented the results of the pilot study at the World Sport for All Congress in Rome, Italy, in November 2004. The congress, organized by the International Olympic Committee in collaboration with the World Health Organization and the General Association of International Sports Federations, brought together 843 scientists, trainers, physicians and coaches from 103 countries. There was a good response to Brown's presentation – including a Romanian scientist working with firefighters and a researcher from Vienna studying electrolyte replacement – and he foresees international cooperation with future research.

Brown credits the foresight and support of Thompson and Fayetteville fire chief Chris Bosch with making the Firefighter Wellness Program possible. While he never underestimates the potential this program holds for improving fitness, reducing stress and saving firefighters' lives, he also sees other important benefits.

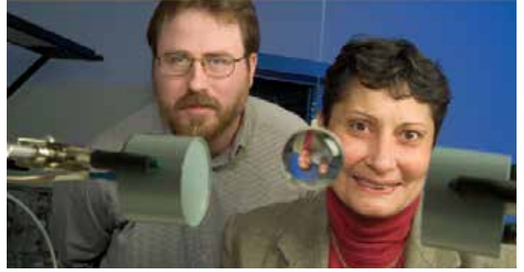
"The real success of this study is the relationships between the students and the firefighters," Brown said. "The real, deep concern our students have when they work with firefighters is the basis of success for the entire program.

"I watched the undergraduate students presenting lessons and the firefighters hanging intently on their words. It's so important to involve our students in real-life research so that they can experience the excitement and contribute something to the community." ■

Photos by Russell Cothren

From left, Barry Brown, University Professor of exercise science; graduate student Leigh Jurney; graduate assistant Marcos Michaelides; and graduate student Koulla Parpa.

Photos By Russell Cothren



Electrical engineering professors Fred Barlow and Magda El-Shenawee are trying to apply technology used to detect land mines to screen for breast cancer.

Detecting Hidden Dangers

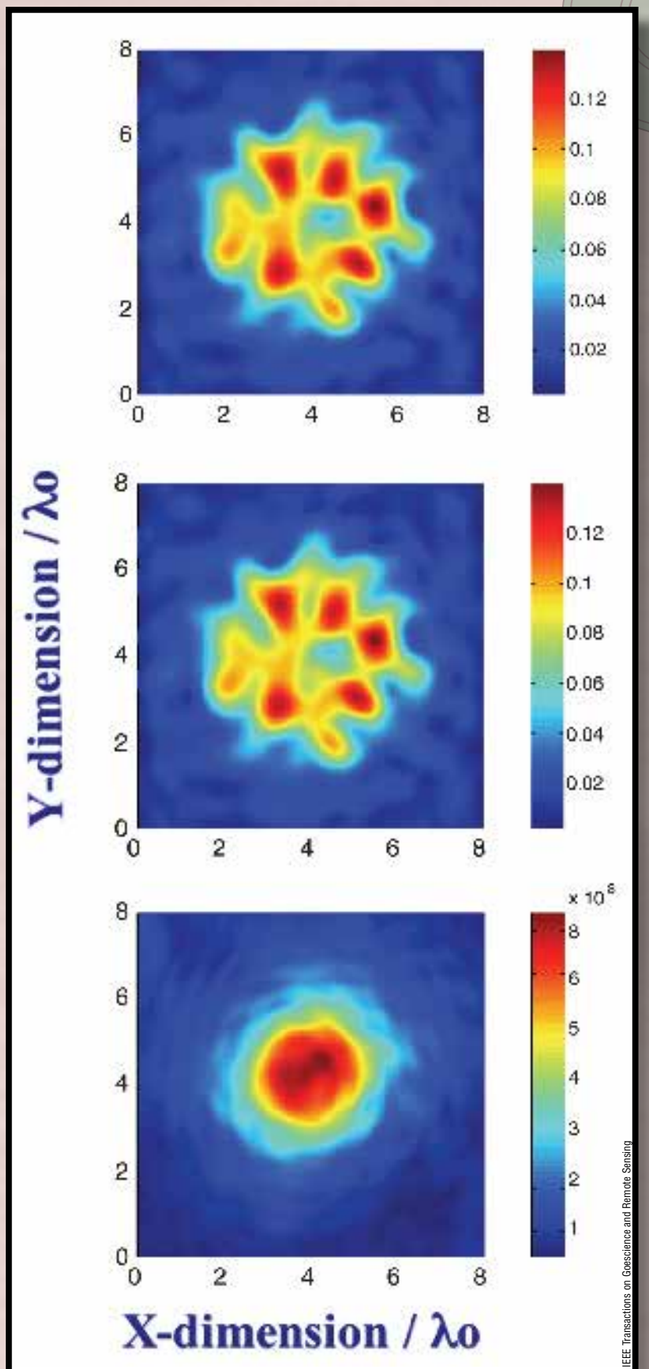
LAND MINES & BREAST CANCER

By Cecilia Vigliaturo

Magda El-Shenawee is an expert in finding what is hidden. As a rough-surface computational scientist, her research probed the dirt of barren minefields and is now revealing the mysteries of the human body.

"You can apply one solution for similar problems or devise similar solutions for diverse problems," said El-Shenawee, associate professor of electrical engineering in the College of Engineering. "Sometimes those diverse problems have more in common than you might think."

El-Shenawee's initial research focused on developing and using a unique, incomparably fast technique called the steepest descent fast multilevel multipole method, or SDFMM, an algorithm that analyzes how electromagnetic waves scatter as they bounce off rough surfaces. Essentially, SDFMM combines rigorous mathematical equations that calculate the electric and magnetic currents on the surface of an object. After learning this technique at the University of Illinois-Urbana, she applied it to study radar scattering from rough surfaces, specifically a situation known as a "low grazing angle." Her work resulted in finding better ways for ships to track missiles over large distances on the sea.



These images represent the signature of an anti-personnel mine buried under rough ground. Top, rough ground only; middle, rough ground with a buried mine; bottom, target signature after 300 computer simulations. The technique used by Barlow and El-Shenawee subtracts the "signature" of the ground, leaving behind the weak signature of the landmine.

Images courtesy of Journal of IEEE Transactions on Geoscience and Remote Sensing

Field and Stream

El-Shenawee first connected land and sea as a visiting scholar working with the Sub Surface Sensing and Imaging Center at Northeastern University, Boston, Mass. "I thought 'Why don't we modify this technique for landmine detection?' It was perfect," she said. So she repositioned SDFMM to develop models that make the mud as clear as the ocean – incorporating the presence of hidden targets as a part of the mathematical model to study the radar signature of small, buried anti-personnel landmines.

"After you spend years working on these huge mathematical equations, you don't just throw them away," she said. "You look around to see what else you might apply them to."

Armed with a garden-variety metal detector, discovering the large, metal anti-tank mines is no problem. But finding small devices in a field presents difficult challenges. First, advances in technology have made new landmines cheap, small and even hard to detect. Factor in wind, rain, heat, cold or geological changes and even with a map, older mines are nearly impossible to locate.

"A simplified assumption made by other researchers was that the ground is flat," said El-Shenawee. One of the biggest challenges in detecting these buried booby-traps is the dirt that surrounds them. That dirt can be gritty, sandy, muddy or even frozen. Further muddying the waters, junk objects might be buried as well, which presents many possibilities.

"Is it a rock? A clump of dirt? Or is it a landmine?" asked El-Shenawee. "It's far too expensive and time-consuming to consider every option."

So she drew upon her background in computational and theoretical electromagnetics and research in rough surface scattering, adapting her equations and applying them to accommodate the natural irregularities of the soil's surface, taking in all possible combinations of peaks, valleys and hollows. She completed hundreds of simulations that held only soil and hundreds that held a buried mine. When placed side by side, the two types of images looked identical.

"But when I subtracted the dirt from the model with the mine and used the model of just the ground as a reference, the hidden landmine suddenly popped up," she said.

The researchers had successfully highlighted the issue of the "signature" of the ground. "Signature" refers to any signal that indicates the presence of an object.

"The signature of the landmine is very small and weak, so subtracting out the very large signature of the ground made the landmine apparent," said El-Shenawee. She then measured and recorded the distinguishing features of the waves that scattered when they collided with a mine.

"Our analysis proved the benefit of inventing a technique to remove the signature of the rough ground,"

From left, graduate student Faisal Magableh, El-Shenawee, graduate student Payam Rashidi,and Barlow in the laboratory where they conduct studies using an algorithm that analyzes the scatter of electromagnetic waves, hoping to apply the technology to breast cancer detection. Other students involved in the research include Mahita Attaluri, Gokul Talapanuri and Shruti Pandalrajv.

said El-Shenawee. One large problem: the conventional methods used to measure the profile of the ground surfaces cannot be used in a field full of hidden landmines.

Though the ultimate goal is to develop sensors to detect those mines, every step forward in theory can mean the difference between actual life and death. Consider: in poverty-stricken countries littered with landmines, the most common method of detection is to crawl on the ground, poking a stick at arm's length.

Unfortunately, funding for research into landmine detection has dried up, stalling further discoveries. El-Shenawee views such setbacks as an inevitable, albeit disappointing, aspect of research.

"My work will be a building block for someone else," said El-Shenawee. "You start from other people's work and you leave your work for others. Long after I die, I might still make a contribution. That's the beauty of research."

Finding Common Ground

How in the world did El-Shenawee link landmines with breast cancer?

"I realized that they're both hidden, they're both dangerous and they both cause death," she said. "All I needed to do was change the parameters of my equations from geological to biological."

El-Shenawee, and Fred Barlow, associate professor of electrical engineering, are about halfway through developing, designing, building and testing a microwave imaging system to work with physics-based imaging algorithms to detect breast cancer – as early as possible while the tumor is still as small as possible. The system, or the hardware, is Barlow's specialty, with the algorithms, or the software, El-Shenawee's, who also contributes her expertise in physics and analysis.

El-Shenawee has received support from NASA, while the Arkansas Biosciences Institute has funded their efforts to develop what might be an alternative or a complement to traditional mammography.

They're planning future collaborations with Vasu Varadan, a world-renowned researcher who recently relocated to the University of Arkansas College of Engineering as the George and Boyce Billingsley Chair and Distinguished Professor. And El-Shenawee is working with John Lusth, associate professor of computer science and computer engineering, to develop artificial intelligence software to indicate whether abnormal tissue is benign or malignant.

"We're definitely not trying to replace mammography," said El-Shenawee. "But this system might offer additional benefits."

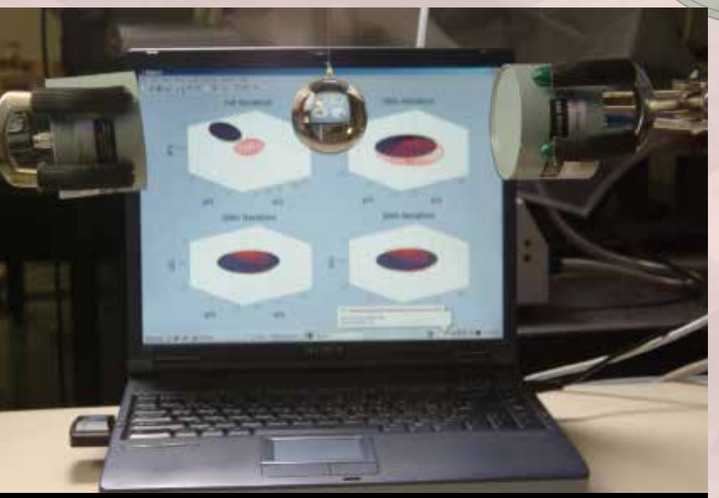
Breaking New Ground

Mammography, which is an X-ray picture of the breast, is by far the most common and reliable detection method currently available. Indeed, though the total

number of women diagnosed with breast cancer has increased, the number of deaths has decreased, which is largely the result of better screening methods, like mammography, which reveal tumors while they're small.

So why bother coming up with another way to detect breast cancer? And what's the difference between mammography and microwave imaging, anyway?

Mammograms are usually done in special clinics or radiology centers. The procedure involves squishing the breast between two plates while an X-ray image is made. As any woman who has had the test knows, it's not painful but it's not exactly comfortable either. Radiologists sometimes have difficulties distinguishing dense normal tissue from possible tumors, which generates a fair amount of false alarms. In addition, mammograms aren't cheap, show the breast in two dimensions and emit ionizing radiation, which means they produce an electrical charge that can lead to unnatural chemical reactions inside cells.



The image on the laptop screen represents custom-made imaging software in progress, developed by graduate student Payam Rashidi. Each picture shows how closely the image produced using the software represents a known target. The first picture shows a big difference between the two images, the second picture shows better agreement, until finally the fourth picture shows very good agreement. This is done to test the software on a known target before applying it to experimental data.

"Being exposed to a very small dose of radiation is definitely a safer bet than to risk breast cancer," said Barlow. "But not being exposed to any radiation would be better yet."

Microwave imaging, on the other hand, would produce a sharp, three-dimensional image without changing the breast's natural geometry. A clearer picture could mean fewer false alarms. And since the procedure is non-ionizing, women might be screened earlier and more frequently throughout their lives. The system also would be small and therefore mobile. That mobility, along with a potentially cheap price tag, would be particularly important for women in third-world countries without access to expensive, complicated-to-build mammography clinics.

Perhaps one of the most exciting differences is the possibility of finding the smallest of tumors. It's possible to detect tumors approximately 3 mm in diameter, but only using a very advanced imaging test, magnetic resonance imaging or MRI, which is expensive and unavailable in some parts of the world. The goal of this research is to spot tumors that are approximately 5mm in diameter in a cheap, efficient manner. As every oncologist preaches, earlier discovery means less invasive treatment and better survival rates.

From Research to Reality

So how would this system actually work?

"We would send electromagnetic waves that would penetrate the breast," said El-Shenawee. "If nothing is there, the waves will proceed. But if a mass is detected, the waves would be deflected and proceed in a different pattern or direction."

Simply put, the microwave imaging system would use a probe and a source – or a transmitter and receiver – to gather information about the tumor.

Barlow uses a cell phone to explain how signals processing functions.

"We're all bathed in an electromagnetic energy," he said. "Basically, a cell phone is a transmitter and a cell phone tower is a receiver. When you talk on a cell phone, the sound of your voice is encoded and that information, in the form of electromagnetic waves, is radiated to the tower. The cell phone tower also transmits the other voice, which is received by your phone."

The team is developing a system that uses a transmitter and receiver, each roughly the size of a large muffin, on either side of the breast. The transmitter would send out electromagnetic waves, just like a cell phone, that would pass through the breast tissue. The receiver on the other side would collect that information.

"Those waves would interact with the breast tissue," said Barlow. "And that interaction would be detected and interpreted."

The way those waves interact with healthy tissue and the way they interact with cancerous tissue are radically different thanks to a measurement called the "dielectric constant." The dielectric constant of a certain material refers to the measurement of the speed and strength of a wave within that material, specifically how much speed and strength the wave loses.

"When the waves interact with normal vs. abnormal tissue, there's a dielectric constant difference of more than five, which is huge," said Barlow. "Normal tissue is very conducive to conductivity, making the waves travel about three times slower, while abnormal tissue makes the waves travel about 10 times slower."

Think about the difference between light waves traveling through salt water and peanut butter.

Even more exciting, there is a significant dielectric constant difference between benign and malignant tissue.

"Eventually, we may be able to use this technology to not only reveal whether a tumor is present, but to find out what type of tumor it is," said Barlow.

Before the team could approach the drawing board, however, they had to prove their idea would work, which highlights the value of virtual reality. "Before we spent a lot of time or money on building the actual hardware, we had to prove that our theory would work," said El-Shenawee. "You can't build a system without knowing that it will work."

Among many possible stumbling blocks, one loomed largest: as the waves hit abnormal tissue, the signals scatter unpredictably. How to capture that "backscatter?"

On the basis of El-Shenawee's theoretical analysis and computational studies and simulations, Barlow is designing the hardware to rotate, capturing those scattering waves as they bounce off at any angle.

"Using a rotating system lets us measure different angles, and using a sweeping-over frequency lets us measure different frequencies," he said.

"Collecting the data from all directions around the breast makes the imaging algorithm extract information about the size, shape and location of the tumor," said El-Shenawee. Those mathematical algorithms allow the software to draw a three-dimensional image of the tissue and the tumor.

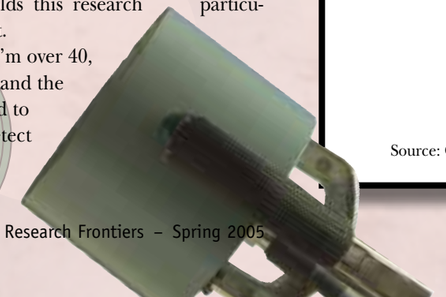
"The hardware gathers the data and the software interprets, or translates, that information," said Barlow. "You might say the hardware gathers the hay and then the software reveals whether there's a needle, how big it is and where it is."

Barlow, who has an undergraduate degree in physics and advanced degrees in electrical engineering, works with a sense of urgency.

"Whether it's your wife, mother, sister, aunt or friend, it seems everyone knows someone with breast cancer," he said. "The work we're doing could benefit a lot of people."

The humanitarian impact also motivates El-Shenawee, who holds this research particularly close to her heart.

"I'm a woman and I'm over 40, so I know and understand the fear as well as the need to find a better way to detect breast cancer." ■



Breast Cancer by the Numbers

13.4
percentage of women born today who will be diagnosed with breast cancer at some time in their lives.

95
percentage of women who survive at least five years when their breast cancer is confined to the breast – making it imperative to detect breast cancer as early as possible.

216,000
approximate number of invasive breast cancer cases diagnosed in women this year.

40,000
number of women who will die from breast cancer this year.

2 million
number of U.S. women who have been diagnosed with and treated for breast cancer.

1
rank of breast cancer among leading causes of death among women age 40 to 59.

Source: Susan G. Komen Foundation

Landmines by the Numbers

1 million
people killed or maimed by anti-personnel mines since 1975.

26,000
people killed or maimed by landmines each year.

75
percentage of landmine victims who are civilians.

70
approximate number of countries affected by landmines.

110 million
landmines in the ground worldwide.

2.5 million
new landmines laid each year.

250 million
stockpiled landmines worldwide.

350
minimum number of different types of landmines.

3
cost in U.S. dollars of a cheap landmine.

1,000
cost in U.S. dollars to remove one landmine.

33 billion
cost in U.S dollars to remove every mine in the world, if no others are planted.

Source: OneWorld International, International Campaign to Ban Landmines

Palindromist Pens Book

By Molly Boyd

Most Westerners tend to think of writing – and reading – as a one-way street moving left to right. But some people delight in reversing the normal order of written language – palindromists. A palindrome is a word, phrase, number, or any other sequence of units – like a nucleotide sequence of a DNA strand – that has the property of reading the same backward or forward. A palindrome can take the form of a mirror image, such as "Dennis sinned," or balance on a fulcrum made of a central character, such as "Go Hog!"

Stephen J. Chism, reference librarian at UA's Mullins Library, (pictured at right) has long been interested in palindromes. While a graduate student, Chism became intrigued with the idea of composing a response to the famous one-line palindrome "Madam, I'm Adam." Chism's imaginative reply, "Sir, I'm Iris," was the first of many palindromes, including such gems as "Devil, in Eve's eyes even I lived" and "Ah, a Mayan on a Yamaha."

Chism's fascination with palindromes ultimately led to the publication of "From A to Zotamorf: A Dictionary of Palindromes," published by Word Ways Press in 1992. The largest collection of English palindromes, containing over 7,000 examples, Chism's dictionary necessitated the creation of a new Library of Congress subject area, where it resides with René Droin's "Dictionnaire extraordinaire des mots ordinaires" (Belfond 1991), the only two entries in the field, a fact that pleases the librarian in Chism.

Nicknamed "Zotamorf," which is itself a reversal of the phrase "from a to z," Chism's dictionary became the all-time best-selling monograph for Word Ways Press and can be found in over 100 libraries on three continents, including the library at the University of Oxford.

"I gave it to them," Chism confides, "when I presented a paper there on palindromes" for the International Popular Culture Conference of 1995.

Chism's palindromes have been quoted in the San Francisco Chronicle and The New York Times magazine, and have been illustrated by Jon Agee in one of his best-selling palindromic cartoon books. Richard L. Marsh of the University of Georgia even used Chism's palindromes in a psychology experiment involving memory retrieval cues.

In explanation of his interest in this ancient form of word play, Chism declares simply, "I'm a Libra." He describes his ability to walk backwards on a single rail of train tracks or to stand stork-like on one leg for 20 minutes at a time. "It's all about balance," he continues. To illustrate, he grabs a book from a stack, balances it on the tip of one finger and spins it deftly, à la Cirque du Soleil. When asked about Michael Donner's statement in "I Love Me, Vol. I" that palindromic outbursts are "a sort of cultivated dyslexia," Chism counters whimsically, "Or perhaps the precision of palindromes serves the stunted mathematical part of me."

The first recorded palindromes are found in ancient Greek texts. The word "palindrome" is a compound of the Greek words "palin" ("back") and "dromos" ("race course"), creating the image of a word or phrase looping back upon itself. The term is attributed to Sotades of Maroneia in Greek-ruled Egypt, whom King Ptolemy II had thrown into the sea – sealed in a lead coffin – in the third century B.C. after Sotades reportedly insulted the king in one of his palindromes. Ptolemy ended Sotades' political career on a heavy note but did not obliterate the continued fascination with satiric and scurrilous palindromes that are still known to this day as "Sotadic verses." Examples abound and include "Yawn! Madonna fan? No damn way!" or Chism's "Drat Saddam: a mad dastard."

Photo by Russell Cothren, illustration by Amanda Ryan

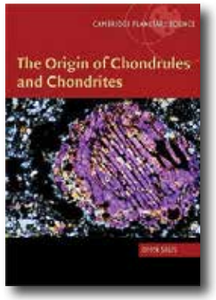
Chism explains that in an era when few people could read or write, the written word itself was fascinating and mysterious. To those illiterate people of ages past, palindromes were often wondrous, or manifestations of the divine. Palindromes were etched on monuments, over doorways, and were even recited over women struggling with a difficult childbirth. Chism writes in the preface to his dictionary, "I believe that human beings are fascinated with palindromes because, in an uncertain world, they provide a sense of order through their perfect balance and symmetry" and "put us in touch with mystery."

The earliest traceable palindrome in English was written by John Taylor in 1614: "Lewd did I live & evil did I dwel." Palindromes can be single words, such as "rotator," "civic," or "nun," but these are rare. Most palindromes take the form of a sentence or brief passage, such as Leigh Mercer's oft-quoted "A man, a plan, a canal – Panama!" Other examples include "Drab as a fool, aloof as a bard" and "Do geese see God?"

In addition, there are palindromic verses and poems, and a palindromic novel of nearly 32,000 words titled "Dr. Awkward & Olson in Oslo," published in 1986 by Lawrence Levine. Longer, however, is not necessarily better, according to Ross Eckler, who writes in "Making the Alphabet Dance" that "palindromic phrases and sentences could be made as long as one pleased, providing that not too much overall sense was required. Most read like the ravings of a maniac." A good example recorded by Howard Bergerson in his "Palindromes and Anagrams" is "Maiden, if no craft so melts a chasse legato poem of foot ageless – Ah, castle most far, confined I am."

"It's an uphill job trying to get people interested in palindromes. The written word is being supplanted by the visual world so easily accessible through television, movies, video games, and the internet," Chism says. Yet palindromes abound in popular culture. Authors including Jonathan Swift, Edgar Allan Poe, Lewis Carroll and W. H. Auden have contributed to the genre. And who could forget the tension-building "redrum" in "The Shining?" From the album title "Live Evil" used by both Miles Davis and Black Sabbath to the protagonist "Stanley Yelnats" in the juvenile novel "Holes" by Louis Sachar, pop culture repeatedly demonstrates the continued appeal of palindromes.

A last palindrome of Chism, "Fini? One more? Rome, no, in… if…," might easily be answered by a more optimistic one from Bill Bryson, "Are we not drawn onward, we few, drawn onward to new era?" ■



The Origin of Chondrules and Chondrites

Derek Sears

Cambridge University Press

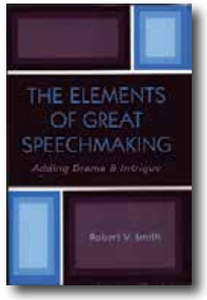
Ancient Greeks, Romans, Japanese and Egyptians collected rocks that fell from the sky, using them for trade or to adorn tombs. Cosmochemist Derek Sears examines the origin of meteorites and their role in the formation of our solar system in "The Origin of Chondrules and Chondrites."

Sears focuses on chondrites, the largest group of meteorites, and on the many theories that have evolved about their formation throughout the centuries.

He meticulously traces the theories that researchers have proposed, from the belief that meteorites came from the Moon to their being ejected from volcanoes on Earth. In the process, he provides a comprehensive bibliography of the latest research and a valuable reference guide for students and researchers in planetary science, geology and astronomy.

Meteorites contain in them the story of how the solar system evolved. Chondrites, the most common ones, are as old as the solar system, 4.6 billion years. The youngest are the 20 or so meteorites from Mars, a mere 1.5 billion years old.

Mass spectroscopy made possible a new discipline in chondrite studies: researchers now could determine their chronology, or the time at which events occurred. The types of events are as varied as the chemistry and physics of the many isotopes found in meteorites. ■



The Elements of Great Speechmaking: Adding Drama and Intrigue

Robert V. Smith

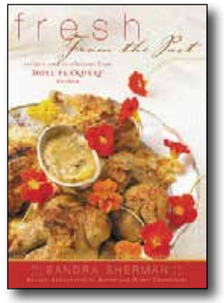
University Press of America, Inc.

For many professionals, speeches inspire quaking anxiety and uncertainty. Provost and Vice Chancellor for Academic Affairs Robert V. Smith has written a book to help those who find themselves stymied at the idea of speaking in front of groups to prepare insightful speeches full of information that will leave the audience engaged and intrigued.

"The Elements of Great Speechmaking" addresses all aspects of presenting information to groups, from the moment of acceptance of a speaking engagement to the last line of the speech. Smith goes deep into the elements that make an excellent speech, instructing the reader on how to add drama and intrigue to a presentation through the use of tools and materials such as humor, quotes, symbols, history, science, literature and props. He demonstrates how to use these elements to create drama and intrigue to a speech from start to finish.

The book is divided into four sections: Presentation pre-planning, tools and materials, crafting presentations and making presentations. It also includes lengthy appendices with examples of humor, quotes, proverbs, historical allusions and themes that the reader can use for inspiration.

Professionals in educational, governmental and corporate positions will find a wealth of relevant information in "The Elements of Great Speechmaking." ■



Fresh from the Past: Recipes and Revelations from Moll Flanders' Kitchen

Sandra Sherman

Taylor Trade Publishing

English professor Sandra Sherman serves up tastes of the past and reveals 18th century British sentiment toward the French in her most recent book.

"Fresh from the Past: Recipes and Revelations from Moll Flanders' Kitchen" is a cultural history of 18th century food. It includes 120 recipes from original sources, updated for modern cooks.

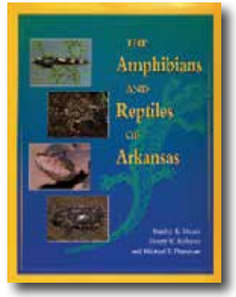
During her research, Sherman learned how British politics affected food preparation during the battle with the French.

Sherman said 18th century British cookbooks tended to attack the French as being extravagant, but they also used French recipes with new names that looked English. The British prided themselves on eating a "strong He-man diet," while the French ate little tiny pieces of meat chopped up in ragouts.

The British even put out tracts criticizing the French and their foods, saying British food was better for British physiology.

The researcher also was amazed at how highly developed greenhouse technology had become by the mid-18th century. Greenhouse technology, developed after 1740, provided the British with pineapples, melons and oranges throughout the year.

"Fresh from the Past" includes photos of 18th century porcelain and silver, as well as prints from the period. The book will be used by food history societies, as well as a model for 18th century dinners hosted by academic societies and restaurants. ■



The Amphibians and Reptiles of Arkansas

Stanley E. Trauth, Henry W. Robison and Michael V. Plummer

University of Arkansas Press

From the identity of the lizard on your backyard fence post to the distribution of venomous snakes in the state, "The Reptiles and Amphibians of Arkansas" offers a comprehensive guide to a fascinating group of creatures and their habitats.

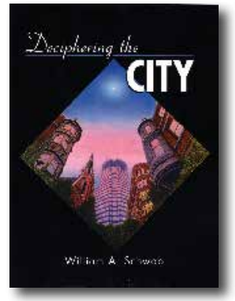
Stanley Trauth, zoology professor at Arkansas State University; Michael Plummer, biology professor at Harding University; and Henry W. Robison, biology professor at Southern Arkansas University, worked for 15 years to create this book featuring 136 species and subspecies with more than 500 photographs and line drawings and more than 100 maps.

The list of animals includes salamanders, frogs, toads, turtles, lizards, snakes – and even alligators.

The book begins with a chapter on the ecoregions of Arkansas, setting the stage for a discussion of the distribution of reptiles and amphibians within the state. This is followed by chapters on observing the animals, conservation and exotic species.

The individual entries for a species usually feature a photograph of the animal, its distribution, habits, habitats and conservation status and remarks. Most entries also have a map that shows the distribution of the species in Arkansas, and occasionally its distribution in the United States.

The book will appeal to both biologists interested in field research and armchair naturalists who want to learn more about these unique creatures. ■



Deciphering the City

William Schwab

Prentice Hall

Watching television or waiting in rush-hour traffic is unproductive, and contributes to the decline in social capital in communities across the United States, says sociologist William Schwab.

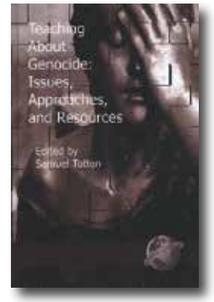
Schwab's book "Deciphering the City" addresses globalization, the psychology and structure of the city, and urban problems and solutions.

Declining levels of social capital mean neighborhoods, schools and communities don't work as well, and Schwab cites sprawl and television as major culprits.

Increased television viewership has led to a decrease in community involvement. For every 10 minutes spent commuting to and from work, community participation declines 10 percent.

Schwab reports that every form of civic engagement has declined in the past 25 years – fewer people vote, run for office, write letters to the editor, volunteer, attend church, read the local newspaper, watch the local newscast, visit neighbors or share family meals.

The book is divided into four sections. The first section introduces globalization and its effect on the social, political and economic institutions in developed and less-developed societies. The second section deals with the psychology of the city and the community-building process. The third section looks at structure and patterns of the city, while the fourth section focuses on urban problems and possible solutions. ■



Teaching About Genocide: Issues, Approaches, and Resources

Edited by Samuel Totten

Information Age Publishing

In Teaching About Genocide, education professor Samuel Totten has selected essays from noted scholars internationally to address a range of issues in genocide education. For example, an early essay outlines a broad historical overview, while later essays present specific case histories of major genocides and offer instructional strategies for teaching about genocide.

Totten makes the case that there is a critical need for a well-informed and caring populace across the globe to prevent genocide. Without such citizens, he writes, "politicians are likely to continue issuing sound bites about the need to prevent genocide and then not acting when genocide rears its ugly head."

As author of the chapter on instructional strategies, Totten recognizes that genocide is a complex topic that demands study of many sources of information. He emphasizes the need for educators and their students to understand how and why genocide is perpetrated, and much of the book is dedicated to closely studying 20th century genocides. Essays examine "situations and decisions (and lack of action) that contribute to and sometimes result in genocide."

Totten argues that only by getting at the "whys" behind the whats, wheres and hows will students even begin to gain a clear understanding of genocide. ■

Question:
Why do hummingbirds hover? And how do they hover?

Douglas A. James, University Professor of biological sciences, replies:

Most of the calories consumed by hummingbirds come from the nectar of flowers, which they consume by reaching into the funnel of the flower with their long beaks. The bird has to be in front of the flower to accomplish this, but there is no perch there. Therefore, the hummingbird hovers in space. Hummingbirds also eat tiny insects as a source of much-needed protein. The nectar is essentially sugar water – no "no-carb" diets for hummingbirds.

The wing of a hummingbird, unlike that of most birds, has a short upper and lower arm, but a long hand – the part we use to make Buffalo wings from chickens, named for Buffalo, N.Y., where the practice originated. The long flight feathers attached to the hand are given circular rotations at the shoulder joint, thus acting like helicopter blades. So a hummingbird hovers in a manner similar to a helicopter – a two-bladed one, each wing functioning as a separate blade. They change the orientation of the "blades" to move forward or backward, and the pitch of the feathers to move upward. The wing beat – or wing circle – is about 50 times a second. Regular birds operate like fixed-wing aircraft, with the up and down wing beats providing forward motion as well as lift. ■

Question: Why do feet stink?

Ed Clausen, professor of chemical engineering, replies:

If the smell of your shoes knocks you off your feet, you've probably wondered just what makes those sneakers stink.

Your fetid feet are fermenting. You have more than 250,000 sweat glands in each foot, so perspiring piggies produce up to a pint a day. It's not the sweat that stinks, though. It's the byproduct of the bacteria that are feeding off the sweat. The bacteria cells eat and then excrete an organic acid. That's what smells.

So it all comes down to bacteria poop…that and the sealed-off sweat stuck inside your shoes and socks. Other parts of your body, such as your hands, have a similar number of sweat glands. But your palms aren't putrid because that dampness dissipates. The clammy conditions of your shoes and socks create a feeding frenzy at the bacteria buffet.

Bacteria love dark, damp places. Fermentation is just what happens when a microorganism breaks down a substance, producing a byproduct. Sometimes, as with beer and wine, we want those byproducts.

Only science could connect booze and shoes. ■

Photos by Eric Pipkin

Photo by Russell Cothren