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Spring 2011

## Research Frontiers, Spring 2011

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### Citation

University of Arkansas Fayetteville. Office of University Relations. (2011). Research Frontiers, Spring 2011. *Research Frontiers*. Retrieved from <https://scholarworks.uark.edu/research-frontiers-magazine/18>

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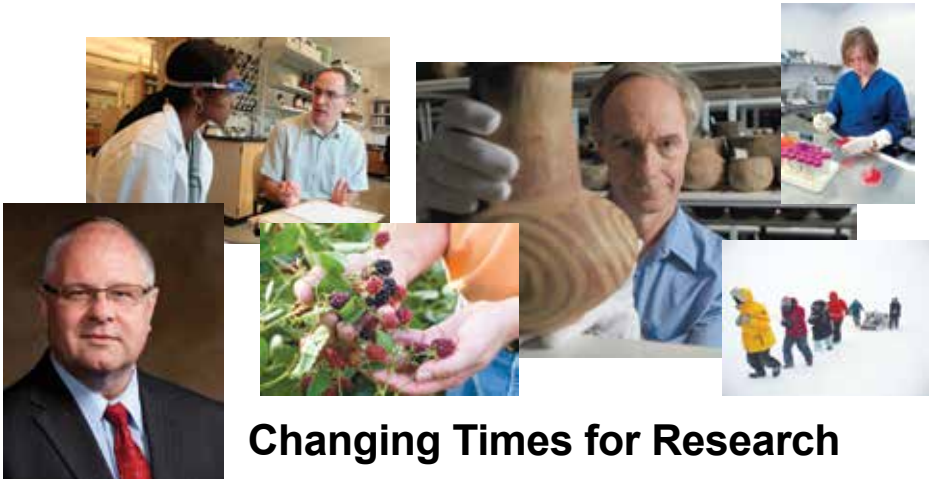
U N I V E R S I T Y O F A R K A N S A S  
**RESEARCH  
FRONTIERS**  
arkansas.edu SPRING 2011

DO WE MAKE  
OUR MEMORIES, OR  
DO THEY MAKE US?



UNIVERSITY OF  
**ARKANSAS**  
— THE YOU OF A —





## Changing Times for Research

Many changes have taken place in the research offices at the University of Arkansas this past year. Collis Geren, who served for many years as vice provost for research and dean of the graduate school, has retired. Because the university has grown so much, it was decided that the two titles would be separated into two different positions. Because of this change, the Office of Research has become the Office of Research and Economic Development.

The university has made great strides in recent years in creating companies in Arkansas based on technologies developed on our campus, and that progress generated the need to add economic development as a component of this office. This will allow the institution to capitalize on the intellectual property developed by university faculty and help license that technology to start-up companies. It also means encouraging the growth of companies in our own “back yard” and providing companies everywhere in Arkansas with the things that they need to be successful.

We have excellent facilities to assist with this, in the form of Genesis, a company incubator for fledgling companies, the Innovation Center, for small businesses that need a little more room, and finally the Enterprise Center, where businesses can expand their research and development laboratories to scale up their work.

To enhance our support of economic development, Carol Reeves has been promoted to associate vice provost for entrepreneurship. For many years, she has successfully advised students creating

business plans for competitions, and she has helped many entrepreneurs at the institution and within the state.

In her new position, she will help create companies that will have jobs for our graduates so that they can stay in the state of Arkansas.

Governor Mike Beebe believes that job growth and education are inseparable, and that the way for Arkansas to succeed is to develop our knowledge-based economy. By expanding our role in economic development through research-based technologies and breakthroughs, we are helping to fulfill that mission.

On the research side, we have undergone some changes to make it even easier for faculty to move grants through our operation. Dennis Brewer, the new director of research support and sponsored programs, will work with faculty members to facilitate the grant process. We have created an associate deans’ committee to keep the dialog between the office of research and the colleges open at all times, and we also meet with the deans periodically.

We have made changes to our research compliance office and our office that looks at human and animal use and protocols. We’re centralizing our information in the area of regulations so that it is easy for people to find information.

All of these changes will help us continue to improve the way we support the dynamic research culture on this campus.

**By Jim Rankin**  
Vice Provost for Research and Economic Development

University of Arkansas *Research Frontiers* is published twice a year by the Office of University Relations in the Division of University Advancement.

Questions or comments should be sent to:  
Editor, *Research Frontiers*  
800 Hotz Hall  
1 University of Arkansas  
Fayetteville, AR 72701  
or sent by e-mail to [rfeditor@uark.edu](mailto:rfeditor@uark.edu)

**Chancellor**  
G. David Gearhart

**Provost**  
Sharon Gaber

**Vice Provost for Research and Economic Development**  
Jim Rankin

**Editor**  
Melissa Lutz Blouin

**Writers**  
Matt McGowan  
Barbara Jaquish  
Andy Albertson  
Michelle Parks  
Jennifer Penate  
Loreal Robertson

**Design Team**  
Roy Cordell  
Amanda Ryan  
Laura Bennett

**Photographer**  
Russell Cothren

**Art Director**  
Eric Pipkin

**Webmaster**  
Chris Nixon

**Graduate School and International Education**  
Interim Dean  
Todd Shields

**Sam M. Walton College of Business**  
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## Theater and the Human Heart

By Loreal Robertson

As an undergraduate piano performance major, Amy Herzberg spent many hours practicing alone. But because she enjoyed the collaborative efforts of theater, Herzberg decided drama was something she “couldn’t live without.” She describes her involvement in theater as having no true “beginning” but rather as something that “just was.” Since then, the University of Arkansas professor of drama has been actress and director for several plays, including *Dirty Rotten Scoundrels*, *Doubt* and *Cabaret*.

“In several productions I’ve been involved in, I’ve gotten letters afterwards, and people have come up to tell me that it has in some way changed their life,” she says.

Herzberg thinks of theater as a form of art that “accesses our own hearts.” Its purpose is to tell the story of what it means to be a human being, to touch lives and inspire individuals to make changes. Its subject is always humanity and often creates an emotional response in its audience whether happy or sad. As performers, “we hope to touch and open the hearts of people who are seeing theater, in a way where they can take on any aspect of what it means to be a human being and truly examine it,” Herzberg says.

She quotes playwright David Mamet, who said, “Theater is one of the last places where a group of people can come together to hear the truth.” She believes in the value of theater and that human nature has the desire to learn through story telling, especially when that story has something meaningful to say.

Herzberg also directs musical theater, combining

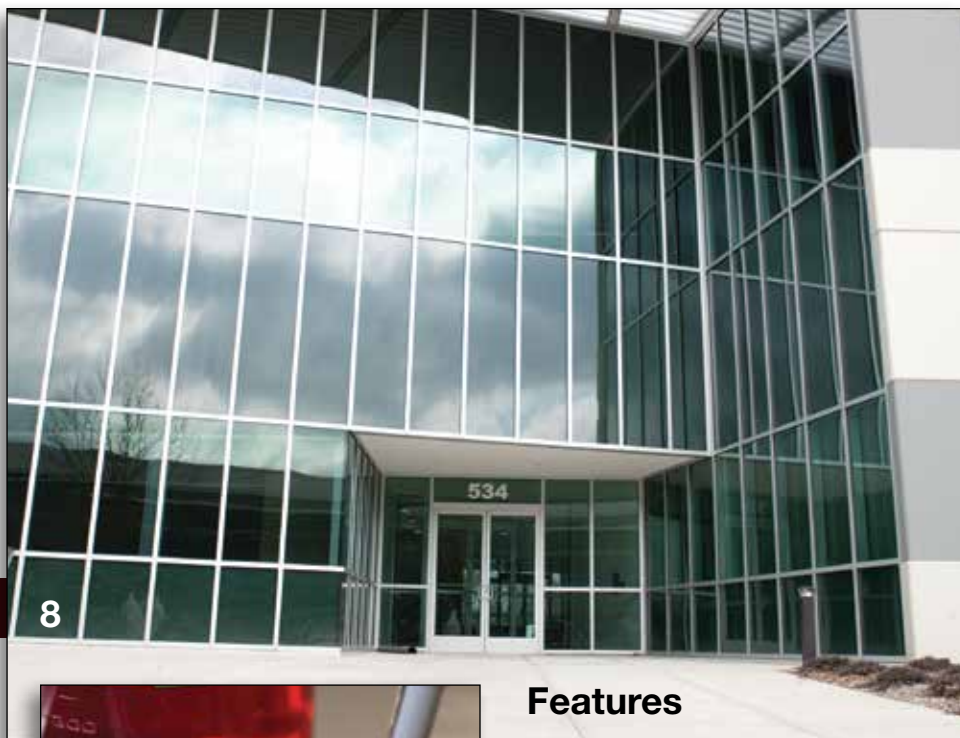
dialogue, songs, and dance. Typically, composers of musicals follow traditional rules; others abandon these rules and are responsible for creating new advancements. “Stephen Sondheim broke, even changed many rules,” Herzberg says. “He created a whole new way to experience musical theater.”

Whether it is a musical, a comedy or a tragedy, theater “allows you to examine the truth in very difficult situations.” Being in the audience and observing the elements in a performance “you’re sitting in a communal space with other people who in their hearts are undergoing similar feelings,” she says.

Herzberg examined some of her own truths in 2008 when she starred in a play titled *My Father’s War*, which premiered at TheatreSquared in Fayetteville, Ark. Written by her husband, Robert Ford, the play tells the story of her father, Arthur Herzberg, and his difficult experiences in World War II. He went to see the play for several nights and would cry during the scene when a man named Bobby Harricausen was killed in the very foxhole he just stepped out of to go get their lunches. Eventually the crying lessened, and he told his daughter that it really helped him to see the play. “The fact that my father has been personally in some way made happier by something that happened in that way: I’m sure you could imagine the layers of meaning it has to me.”

In the play, she portrayed the roles of both herself and her 19-year-old father. “I’ve never had a role that required more of me or gave more back to me,” she says. “It was an amazingly special event.” ■

U N I V E R S I T Y O F A R K A N S A S  
**RESEARCH FRONTIERS**



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It took an engineer to think that a component of lobster shells combined with a powerful drug injected into a tumor could provide treatment for certain types of cancer. Biomedical engineer David Zaharoff discusses how it all came together.

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### Teeth Tell Tales

See select images of illustrations drawn by a professor for his book on the origin of mammal teeth.

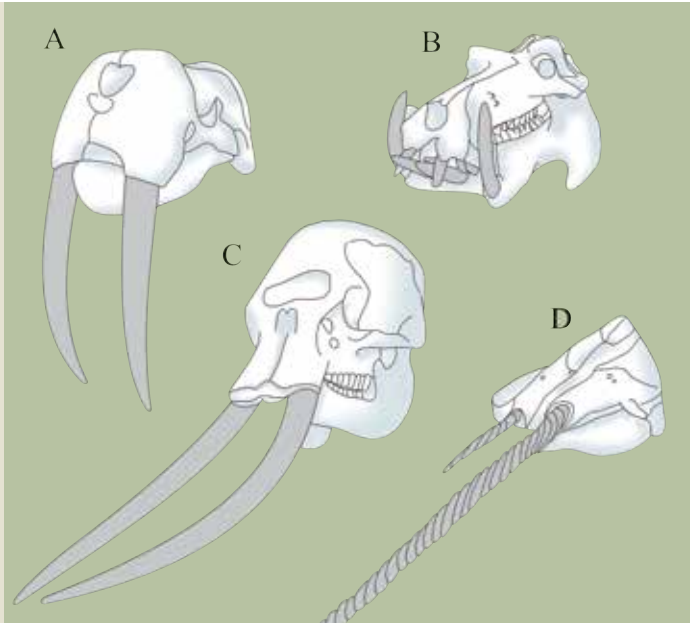


Image submitted

### Probe Used to Determine Efficacy, Toxicity of HIV Drugs

A biomedical engineer has developed a molecular probe that can simultaneously detect the presence of HIV-1 protease and toxicity levels of chemical compounds used to combat the deadly virus that causes AIDS. The probe can be used to investigate the efficacy and efficiency of HIV drugs, some of which are so toxic that many patients elect to stop treatment.

“Because our screening system detects biochemical activity related to HIV and the toxicity of drug compounds at the same time, it can be used to determine whether a given combination of drugs is effective,” said Sha Jin, assistant professor in the College of Engineering. “The ultimate goal is to identify more effective and affordable drugs to treat HIV.”

Although it is currently incurable, HIV can be controlled by anti-HIV drugs, which suppress or inhibit virus replication in patients. Currently, treatment of HIV infection depends upon a strategy called highly active



This image illustrates HIV-1 protease activity detected by Sha Jin’s molecular probe.

antiretroviral therapy, in which drugs that inhibit HIV-1 protease – a family of enzymes essential for the life cycle of HIV – are combined with drugs that suppress virus replication. Although the therapy has reduced mortality, it has side effects. A quarter of patients with HIV stop therapy within the first year due to symptoms related to its high toxicity.

To address this issue, Jin created a screening system by applying fluorescent proteins, one green and one red, to generate Förster resonance energy transfer signals responsive to HIV-1 protease inhibition and activity. Förster resonance energy transfer is a mechanism of energy transfer between a donor and receptor chromophore, the part of a molecule that is responsible for its color. The energy transfer prompts reactions from cells in the form of color. In the absence of protease inhibitors, the researchers observed green and yellow cells. When protease inhibitors were added to cells, they showed a red color.

“We confirmed that compounds nelfinavir and lopinavir were toxic to cells, since many healthy cells died after two days incubation,” Jin said. “Indinavir, zidovudine, and zalcitabine showed less toxicity.” ■

### Combining Salt with Heat Shows Way to Reduce *Salmonella*

Poultry processors trying to keep *Salmonella* off their products may have a new procedure at their disposal: add some salt and turn up the heat. It’s more complex than that, but it’s the key point of recent research by Sara Milillo, a postdoctoral research associate in food science at the University of Arkansas Division of Agriculture.

“Our goal is to come up with a multiple hurdle treatment where we combine things to help prevent bacterial resistance by using different treatments that attack different functions or parts of the cells simultaneously,” Milillo explained.

Milillo’s study, published in the *Journal of Food Science*, examined the application of heat plus an organic acid salt solution to reduce *Salmonella* on chicken. The combined treatment lowered the amount of pathogen, leading Milillo to conclude that it may represent an effective method for decontaminating poultry carcasses during processing.

Milillo also tried heat and salt treatments separately and found that neither one could do the job alone.

She ran the experiments using chicken juice, a raw chicken model medium, rather than chicken carcasses. The results tell enough of a story to draw valid conclusions, but more information will be available by using chicken carcasses.

“We’re hoping the chicken juice gets us a step closer to an actual raw poultry system,” Milillo said. “But by using chicken juice initially we can screen lots of treatments and narrow down what’s the most effective before we go into a more costly use of actual carcasses.”

Milillo and industry personnel have reviewed processing procedures that could be adapted to the research findings. Heated washes are used to clean carcasses, so a salt additive in a heated rinse might be one place to implement new methods. ■



Post-doctoral research associate Sara Milillo streaks plates on which cultures of *Salmonella* will be grown.



Background image courtesy of NASA

### Big on the Little Things

A local company uses nanotechnology developed at the university to provide solutions to societal problems.



Photo submitted

### A Celestial Celebration

The Arkansas Center for Space and Planetary Sciences celebrates 10 years.



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## Tiny Amounts of Neurotransmitter Offer Big Clues to Women’s Hypertension

Research took a step toward understanding hypertension in women by using a new technique to examine the release of a neurotransmitter in small blood vessels.

After menopause, women have an increased risk of hypertension, and among older adults, more women than men have hypertension. Yet, research in hypertension has focused on males, and little is known about how women’s bodies manage blood flow.

“The answer to why women have more problem with hypertension seems to be in the synapse,” said exercise scientist Heidi Kluess.

The synapse is the space between the nerve and the vascular smooth muscle, the place where the nerve and blood vessel interact. A neurotransmitter crosses the synapse to activate a receptor, which then causes the artery to constrict.

“There’s been a little evidence to say that some of the neurotransmitter breakdown is different in women. It suggests that when we’ve been looking at receptors on the smooth muscle, we may have been missing a big part of the story, particularly in women,” Kluess said. “That’s where I started from.”

Kluess measured the neurotransmitter adenosine triphosphate (ATP) coming from the small blood vessels known as arterioles. ATP plays a key role in controlling blood flow and blood pressure by causing the diameter of blood vessels to change. Thus, the constriction of veins associated with hypertension could be related to relatively high levels of ATP in arterioles.

Kluess’ first set of questions were aimed at understanding where the ATP comes from, what tissues are releasing it and how this changes with aging.

The researchers found that ATP is released mostly from the sympathetic nerves in the arteriole wall and that only a small part comes from the smooth muscle.

They also found that the ATP overflow varied considerably with age. Because ATP is associated with vascular growth, it is important during early development when blood vessels are growing, but levels generally decline when people reach their twenties. Elevated levels can be a bad sign during aging and may be a predictor of vascular changes that can be detected years before hypertension is a problem. ■

## ‘Blockbuster’ Exhibit Imagines Increased Housing

Carl Smith wonders how continued population growth will make northwest Arkansas look in 40 years. In order to imagine it, he’s created an exhibition with thousands of tiny, wooden boxes.

Smith, assistant professor of landscape architecture, created this exhibit with Bethany Springer, assistant professor of art. Smith’s idea is rooted in an exhibition he saw by West 8, a renowned Dutch urban design and landscape architecture firm, which used tiny wooden houses to prompt discussion about the housing boom in the Netherlands.

He wondered if something similar would work for northwest Arkansas. The result is an interactive exhibition titled “Blockbuster: Imagining a Future Fabric for Northwest Arkansas.”

It’s easy to toss out numbers, like the 37,500 new homes expected in Fayetteville by 2050, or even the estimated 25,000 for Bentonville in that time.

“Those numbers don’t really mean that much unless you can demonstrate to people what that actually looks like,” Smith said.

So those homes are represented by tiny wooden pieces, each approximately 1-inch long and a half-inch deep and tall. On a scale where an inch represents 45 feet, these wooden “homes” stand in for roughly 2,000-square-foot homes.

Smith, who’s from England, said that country covers about as many square miles as Arkansas, yet Arkansas has a population of just about 3 million compared to England’s 51 million.

“When you’ve got so much land, it’s difficult to perceive there being a problem,” he said. “I think that underscores a lot of the sprawl that’s occurred in the U.S.” ■



Photos submitted

## Virtual Reality Gives Insight on 3-D Protein Structures

To understand a protein, it helps to get inside of it, and a biochemistry professor has figured out a way to do so.

James F. Hinton, University Professor of chemistry and biochemistry, worked with Virtualis, an advanced visualization company, to create a computer software program and projection system that lets researchers look at larger-than-life, 3-D structures of proteins in virtual reality. This allows scientists to walk inside, through or around a protein to investigate its structure and function.

“Proteins are very complex molecular structures,” said Hinton. Proteins are built from amino acids, molecules that share certain characteristics and have unique side chains. Yeast proteins can have 466 amino acids, while the larger proteins have almost 27,000 amino acids. These amino acids interact to form a structure for each protein, and this structure helps determine the protein’s function.

Since proteins underlie most human diseases, they interest researchers studying the mechanisms of disease. The flu

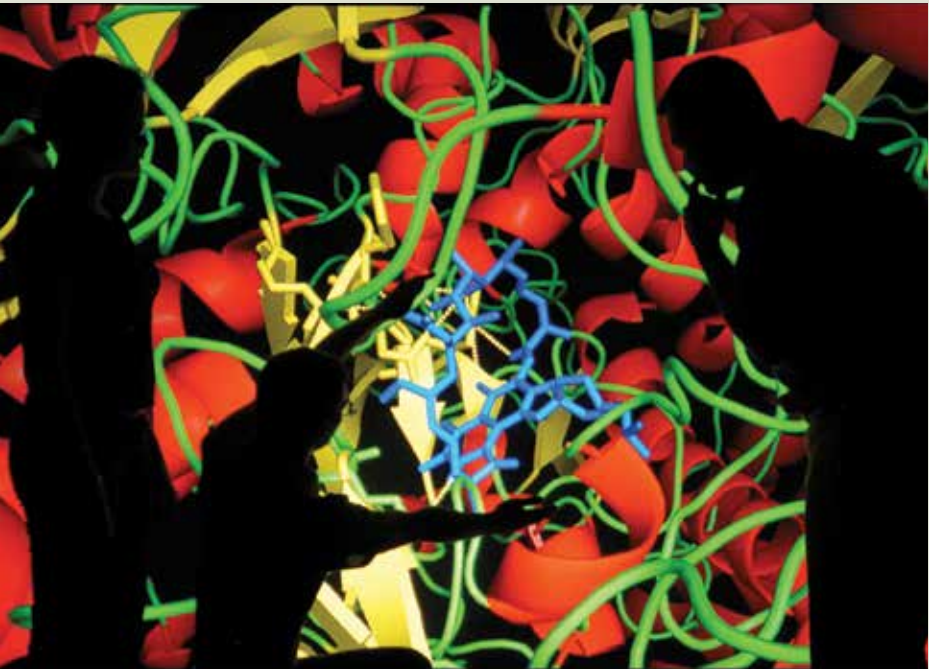


Photo submitted

Virtual reality allows scientists to gain insight into protein structures from the inside out.

virus, for instance, harbors proteins that cause the illness experienced by humans. Figuring out how to neutralize these proteins could help treat or prevent disease.

Examining protein interactions in two dimensions ranges from tedious to impossible because of the proteins’ size and complexity. This system allows researchers to enlarge proteins to room-

size and examine them from all sides, including the inside.

“Using this system, we can answer many questions about interactions. Why does a toxic protein do what it does? Does the protein form a channel? If it does, what does it look like? And how can we block it?” Hinton said. “This system can act as a guide for what to do next.” ■

## Peripheral Developers Increase Product Quality

An information systems researcher has found that peripheral developers – those outside the core development team – make important contributions to product quality and significantly influence product awareness and adoption.

“Our interviews suggest that peripheral developers are very active promoters of the products they’re involved with,” said Pankaj Setia, assistant professor in the Sam M. Walton College of Business. “Using personal channels such as blogs and websites, these volunteer developers associate their identities with these products, and in this process, they become the ideal product emissaries. Working outside the traditional software development paradigm, they have greater credibility with potential consumers.”

Open-source software development is based on the community paradigm in which source code for software is available for anyone to study, change and improve. In contrast to the proprietary approach, open-source development relies on ideas from external

developers and prospective users.

Examples of open-source software products include content-management systems such as Drupal, Joomla! and MySQL. The popular Web browsers Mozilla Firefox and Google Chrome began as open-source software products.

Setia and his colleagues used longitudinal data from 147 open-source software products. The researchers asked, among other things, if peripheral developers have a positive impact on product dissemination.

The results showed that peripheral developers served as sources of information to enhance product awareness and adoption. This occurred through word-of-mouth via blogs, websites and other online communities. Setia said software firms should not underestimate the significance of this finding.

“Our study has important implications for marketing managers at firms espousing open innovations,” he said. “The peripheral participants may be an important way for marketing managers to bridge different types of product promotion. In other words, they may not have to choose between mass advertising and the more personalized effect of promotion via word-of mouth.” ■



*Purple Heart  
for Military Merit*

# Magnifying A Distinct Badge of Honor



By Jennifer Penate

For almost a decade the war in the Middle East has been in full force. Countless news entities have given the world a dose of the chaos millions undergo, but through the media we only learn a thin layer of the reality. While many of us are chatting with an old friend on Facebook or enjoying a relaxing jog at the park, the lives of thousands of soldiers are either ending abruptly or are spiraling down a black hole that will take them to a state of physical, emotional and psychological trauma beyond what they ever imagined.

Some research has torn down the walls surrounding the impact the war has had on soldiers. However, most of the research conducted has been centered on males and their specific ways of adaptation to trauma and physical disabilities.

Although women have been in active duty for years, the Iraq and Afghanistan wars are the first time all deployed servicewomen are in combat zones doing the same jobs as men. Over 1,200 American service members have lost limbs as a result of these wars, yet there is little research, especially on women, on how they are adjusting to life without one or more limbs.

As part of her dissertation, University of Arkansas doctoral graduate Janet Cater interviewed six women amputees to learn about their psychosocial adjustment to the loss of one or more limbs.

"There is little research on the psychosocial adjustment of women to amputation. As more and more American servicewomen receive combat injuries, such as amputation, it is critical to understand how they adjust to limb loss," Cater says.

Over the course of about five months Cater researched and wrote her doctoral dissertation on their physical, emotional and psychological challenges. The women ranged in age from 20 to 36 at the time of injury. Five of the women were injured by either a rocket propelled grenade or an improvised explosive device while in combat. Two women lost both legs, one woman lost one leg above the knee, one lost an arm and the other both arms. The sixth woman Cater interviewed had a leg amputation after a motorcycle accident and later served on a tour of duty in Iraq on a prosthetic leg.

Through phone conversations and interviews on Skype, she learned why these women chose to serve in the military and how their lives changed after their injuries.

She discovered that these women had a "kick-butt" attitude promoted by the military environment around them and that their recovery was influenced by the belief that their loss had meaning. The fact that their amputations occurred while protecting their country and freedom helped them cope with their injuries. For these women their loss of limb was a badge of honor of their service to the country that is usually ignored by the public.

Cater stated that while servicemen amputees are often thought to have received their injuries due to war, society does not accord the same recognition to servicewomen.

"If a young man goes out in public after suffering an amputation, people automatically think it was because of military duty and so he gets praised," Cater says. But women often experience disbelief.

"People don't tend to believe that these women perform the same duties as men and that they too can get hurt," Cater says.

"One of the women I talked to told me she makes up stories about how she lost her arms because many people don't believe she received those injuries as an explosive ordnance disposal technician in the Iraq War."

The message all six women want to deliver through this research was that they would like to be appreciated for their service just as much as men are. Cater says that the disbelief the women receive is very disappointing, because they feel they too deserve respect and appreciation for their military efforts.

Through her study, Cater learned that these women have a high amount of resiliency. They all used humor and personal courage to cope with the changes life threw at them. Adaptation is the key to living everyday to the best of their abilities.

"One of the ladies can actually beat her husband in videogames while using her toes to work the controller," she says.

With positive outlooks on life, these women are actively pursuing their goals with determination. Three are currently employed. One is taking her boards to become a prosthetist to help women in situations similar to hers regain confidence and control of their lives, and the remainder are either enrolled or planning to attend college. Two women continue to serve in the military: one has applied to become a helicopter pilot and the other turned down full medical retirement to continue to serve.

The six women that Cater got to know are only a few of the many that risk their lives for the safety of Americans. Over 220,000 servicewomen have fought in name of the United States since the beginning of the war: 130 of have died, over 600 have been injured and about 24 have lost one or more limbs.

The strength of these servicewomen as well as their unwavering pride amazed Cater. They chose to share their stories to help future servicewomen amputees and to advocate the great need for support and care for women who are experiencing the same struggles.

"It makes you put things in perspective. For these women every day is a struggle to adapt to the loss of limb. It makes you appreciate the ability to accomplish simple tasks simply because you have all of your limbs intact," Cater says. ■





# A COMPANY IS BORN

## HOW AN IDEA BECOMES A *business*

THE ARKANSAS RESEARCH AND TECHNOLOGY PARK HELPS  
RESEARCHERS TAKE THEIR INNOVATIONS AND MAKE THEM  
INTO PRODUCTS THAT BENEFIT SOCIETY.

*By Melissa Lutz Blouin*

A lab on a chip, nanocrystals in solution and miniaturized power modules probably don't mean much to the average person. But testing for traumatic brain injury on the spot, developing more energy-efficient lighting and more economical hybrid electric vehicles might, and that's exactly what each of the innovations above has become, thanks to the hard work of many scientists and support from the Arkansas Research and Technology Park. The following pages contain three profiles of up-and-coming companies in different stages of creating products based on research findings.

Growth in the Arkansas Research and Technology Park has exploded: The Innovation Center, built in 2004, has 35,000 square feet of space. Six years later, the Enterprise Center has opened with 60,000 square feet of space that can accommodate offices as well as wet and dry laboratories. Together these two centers facilitate the commercialization of research and will be useful for companies that are just beginning to grow.

The three companies featured here, as well as NanoMech and Duralor, featured in a video on the Web, represent the first tenants of the new building – merely the beginning of a period of growth for technology businesses in Arkansas. The possible economic impact of companies within the Arkansas Research and Technology Park could be up to \$134 million over the next five years, according to a report by the University of Arkansas Technology Foundation.

"It has been very gratifying to see the evolution of these companies, as it represents a fulfillment of our strategic plan," said Phil Stafford, president of the foundation. "The path to commercialization is neither quick nor easy, but through the development of an innovation system consisting of facilities, equipment, workforce and the culture necessary for product development, the foundation is reducing the barriers that exist between idea generation and product launch."



## SFC *Fluidics*

Scientists have long wanted to make small “laboratories” – handheld devices that allow researchers to perform tests on the spot, in the field. SFC Fluidics has taken technology to do that and applied it to the real-world problem of traumatic brain injury.

“A person will be able to take a tiny blood sample, much like one might for a diabetic blood sugar test. They’ll insert the sample into the device, and it will indicate if a traumatic brain injury has occurred and how severe it is,” said Forrest Payne, senior scientist for the company. The company got a \$5 million grant from the U.S. Armed Forces for a four-year project to create this device using technology licensed from various institutions.

“It’s a great opportunity to help people who potentially have these injuries,” Payne said.

The company is in the first year of the four-year grant. They have developed the pumps and the miniaturized capabilities as well as the connections for the device, and currently they’re building the prototype.

Payne returned to Arkansas after getting his graduate degree from the University of Virginia. He got his undergraduate degree in physics at the University of Arkansas and his parents live in the area. He wanted to move back to the area, but jobs for physicists are scarce in Arkansas. SFC Fluidics provided him with the opportunity to return to Arkansas with a good job.

## ARKANSAS POWER ELECTRONICS *International*

“It’s kind of a Cinderella story,” said Sharmilla Mounce, business operations manager for Arkansas Power Electronics International, Inc. In 2002 she and Alex Lostetter, chief executive officer of the company, worked for free for a year and maxed out their credit cards to start the company with former colleague Jerry Hornberger. Today the company has 30 employees and \$3 million in revenue, but for a short time it looked as if the company would go nowhere at all. Grant money appeared just a week before Lostetter left for a paying job.

“We all wanted to be in Arkansas, but there aren’t a lot of high-tech jobs here,” Mounce said.

The company grew by capitalizing on technology to make things smaller – in this case power modules used in vehicles, geological exploration and the aerospace industry. To shrink the size of such devices, company scientists have focused on silicon carbide. Silicon carbide can operate at temperatures up to 600 degrees Celsius, unlike other currently used materials, which operate at about 125 degrees Celsius.

“If you can have electronics operate at higher temperatures, you need less of a cooling system,” Mounce said.

With their first grant in hand, the engineers took the unusual step of creating a motor drive from scratch to demonstrate that their concept would work.

“We grew everything from the ground up, from the sweat that people put into the company,” said Lostetter, and the work paid off. They kept that first motor drive as a reminder of how they

started. It has a place in the same room with the *R&D 100* magazine’s award for their work on a state-of-the-art power module.

A joint development between APEI, the university, Rohm Company LTD., and Sandia National Laboratory, the APEI power module is the world’s first commercial high-temperature silicon carbide-based power electronics module. With applications in hybrid and electric vehicles, renewable energy and electric aircraft, the APEI power module reduces size and volume of power electronic systems by an order of magnitude over present modules. It also reduces energy loss by greater than 50 percent, which translates into significant potential energy savings.

They have worked with a major aeronautics company to put wireless sensors on turbine blades to monitor them for vibrations. The tips of these blades can heat up to about 500 degrees, so silicon carbide can effectively work for these sensors where other materials will not.

Based on these and other successes, the offices for APEI have expanded from a 150-square-foot room to 10,000 square feet of research and development space and 10,000 square feet of manufacturing space in the new Enterprise Center, which opened in October.

“We’ll be able to take things from an actual concept all the way to a product,” Mounce said.

The company has not sought venture capital to grow; instead, the company is employee owned.

“That’s a challenging way of doing things,” Lostetter said.

Photo by Russell Cothren



From left, David Battaglia of NN-Labs, Sharmila Mounce of Arkansas Power Electronics International and Forrest Payne of SFC Fluidics all live in Arkansas thanks to jobs at businesses created through University of Arkansas research.





Photo by Russell Corhen

“It also lets us go where we think we ought to go” in terms of research and development.

Of their 30 employees, 23 have bachelor’s degrees and three are pursuing their bachelor’s degree. Seventeen people have or are pursuing degrees beyond a bachelor’s degree. And most of these employees either have a degree or are pursuing a degree at

the University of Arkansas. The company’s policy of supporting employees in furthering their education, plus flexible work hours, free health club memberships and a commitment to work-life balance helped the company win the Silver Award for small companies in the Governor’s Work-Life Balance competition. “It all comes down to having good people,” Lostetter said.

## NN-Laboratories

In 2002, Xiaogang Peng, a professor of chemistry and biochemistry, synthesized nanocrystals in suspension using environmentally friendly methods that had not been seen before. Shortly thereafter, he founded a company at the Arkansas Research and Technology Park to examine possible applications for these nanocrystals.

Peng recently returned to China, but the company he founded, NN-Laboratories, continues to do research and development in Fayetteville. The company also has a subsidiary called NN-Crystal that specializes in applying the technology to lighting.

The nanocrystals can power solid-state lighting used commercially. Lighting consumes more than 20 percent of the energy used worldwide, and most current light sources are inefficient: An incandescent light bulb is about 1-3 percent efficient, while fluorescent light bulbs are about 20 percent efficient. In contrast, solid-state lighting, also known as LED lighting, can be up to 50 percent energy-efficient. Furthermore, this LED lighting lasts much longer than standard bulbs: Incandescent bulbs last about six months, fluorescent bulbs anywhere from a few months to three years, and LED lighting can last up to 10 years.

“Imagine a hotel lobby in Las Vegas. There, the cost of a light is trivial compared to the cost of replacing those lights,” said Suresh Sunderrajan, president of NN-Crystal.

Despite their increased efficiency, LEDs have proved a challenge, because they are monochromatic — they do not emit white light, which is a combination of all types of light. Instead, they can only emit colors like red, blue and yellow. LEDs are made to produce white light by combining a blue LED with a yellow phosphor, a substance that glows when exposed to electrons. The combination of blue and yellow makes white. The quality of white light produced this way is poor, however, with relatively poor color rendering ability.

“This can cause a blue jacket to look gray, for instance,” Sunderrajan said. High-quality light mimics sunlight, the human’s natural standard, and the light from LEDs is not considered to be of high quality unless other colors beyond blue and yellow are added, which cuts back on the light’s overall efficiency — the light may look better, but the amount of light emitted is lower for the

same amount of energy.

“We fix that problem with our technology,” Sunderrajan said.

NNCrystal has created a technology called Qshift Coral, which uses quantum dots to precisely control color. They can be used to augment the color of light emitted by LEDs to produce high-quality white light without sacrificing efficiency. Since these quantum dots are tunable — the optical properties can be controlled to change the color of light they emit — the lights can be “tuned” to create almost any other color or color combination on the spectrum.

The second technology being introduced by NNCrystal, Qshift Lucid, features nanoparticles that are color-free in ambient lighting and can be combined with different LED lights, yet will look clear like traditional lights when turned off. This technology can be used to build all of the colors in the sun’s spectrum.

“It’s just like having the sun indoors,” Sunderrajan said.

The company demonstrated the technologies at Lightfair 2010, the lighting industry’s trade show. Their technology caught the interest of Renaissance Lighting, a company that was recently bought by Acuity Brands, which has about \$1.6 billion in annual sales.

Qshift Coral is available commercially now, and Qshift Lucid should be available next year.

The company employs 15 people, four of whom have doctoral degrees in optical physics, polymer engineering and synthetic chemistry.

“The focus of the Arkansas lab is taking an idea from its synthesis to proof of concept,” Sunderrajan said.

Beyond lighting, NN-Labs is looking at advanced applications in the life sciences, such as medical diagnostics, as well as possible use to enhance the performance of solar cells.

Point your smart phone here to see a video about another company in the Arkansas Research and Technology Park. ■

Visit [researchfrontiers.uark.edu](http://researchfrontiers.uark.edu) or download a QR code reader to your mobile device and scan this code.







## From Bench to Bedside:

# Research Shows Promise In Treatment of Cancers

By Matt McGowan

This story begins in 2004, when Jeffrey Schlom, chief of the Laboratory of Tumor Immunology and Biology at the National Cancer Institute in Bethesda, Maryland, took a risk and hired an engineer with no immunology experience. Though it was a bold move, it also made sense, because the investigators in Schlom's lab are trying to develop vaccines and immunotherapies that can be moved from the laboratory to human clinical trials in no more than 10 years. Researchers call it "bench to bedside," and when the emphasis is on saving lives tomorrow, sometimes calculated risks are in order.

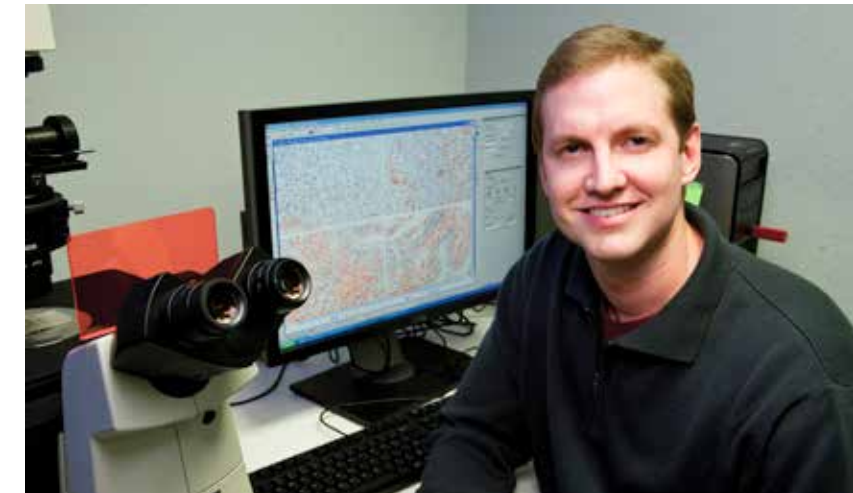
David Zaharoff, the first engineer ever to work in the tumor immunology and biology lab at the National Cancer Institute, had just finished a one-year postdoctoral fellowship at Duke University, where he had received his doctorate in biomedical engineering. While there, Zaharoff had worked on methods to improve the way pieces of DNA are delivered within the human body for gene therapy applications. Some of this investigation involved physical mechanisms, and some of it involved biomaterials.

During this period Zaharoff became interested in immune responses, a curiosity that would steer him toward the job at the National Cancer Institute. He attended numerous conferences at which investigators talked about the potential of new delivery systems for gene therapies and drugs. However, he became frustrated by the lack of research on how these new delivery systems would be recognized by the immune system.

"At these conferences, the emphasis was always on the effect of this or that drug or gene therapy, but immune response was left out," Zaharoff says. "Every single drug or gene delivery system placed in the body will generate an immune response for better or for worse. I felt my career was going to be limited unless I understood the nature of these immune responses."

## Floundering Around

In Schlom's lab, Zaharoff had some catching up to do. Compared to other investigators, he entered with a limited background in immunology. But Schlom and others were patient.



In 2009, David Zaharoff came to the University of Arkansas after several years at the National Cancer Institute in Bethesda, Maryland.

They gave him time to learn their field. Zaharoff describes this period as "floundering around," but he knows it was anything but.

"I spent those years learning about immunology," he says. "Here I was, an engineer working with a bunch of classically trained immunologists. It was a bit like learning a foreign language in a country where no one speaks English. So I studied the evolution of cancer vaccines and immunotherapies, and I realized that no one really focused on the delivery aspects of cancer vaccines."

After two years of "floundering," Zaharoff found his niche. He realized that cancer vaccines and immunotherapies could be made more effective if they were delivered to the right place, at the right time and at the right concentration in the human body. In short, there was a delivery design problem. As an engineer, that was exactly what he needed.

## Lobster Power

Zaharoff concentrated his efforts on developing safe and efficient means to localize therapeutic cytokines – proteins that produce an immune response – to make vaccines and immunotherapies more effective. Controlled- or extended-release delivery systems had been explored in drug delivery for decades, but these systems were unlikely to work with proteins because the systems used harsh chemicals that could destroy proteins.



One day, Zaharoff read an article about chitosan, a polysaccharide derived from the shells of crustaceans such as shrimp and lobsters. Chitosan had been evaluated for use in studies on a wound dressing, a weight-loss supplement and a nasal-delivery system. In chitosan, Zaharoff thought he might have found what he was looking for – a biomaterial that could be used to hold and slowly release cytokines nearly anywhere in the body. Chitosan satisfied his short list of criteria for an ideal delivery system. It was a biocompatible and biodegradable substance that did not require harsh organic solvents. In two early publications, Zaharoff showed that chitosan could indeed enhance immune responses and increase the effectiveness of cytokines.

### Almost Fell Off the Planet

In 2006, Zaharoff began a fruitful collaboration with John Greiner, staff scientist and head of the cytokine working group within the Laboratory of Tumor Immunology and Biology. As Zaharoff focused on delivery systems in general and chitosan specifically, Greiner shared his expertise in cytokine biology. After the initial publications on chitosan, Zaharoff and Greiner wondered if they could deliver any cytokine to any location in the body. If so, which cytokine would work, and where would they put it? Interleukin-12 (IL-12) immediately came to mind. IL-12 is a powerful cytokine that stimulates the body's immune system to

attack a range of cancerous tumors. It had been effective in animal studies, but severe toxicities in human trials ceased its commercial development. Greiner had worked with IL-12 in the early 1990s and still had some in a freezer. "I knew that due to toxicity problems, IL-12 had killed a couple patients in clinical trials in the mid '90s," Zaharoff says. "Since that time, it had been out on the fringe. No one really wanted to touch it. It almost fell off the planet. But this wasn't because IL-12 was a bad drug; we just weren't delivering it in the right way."

### The Bladder Study

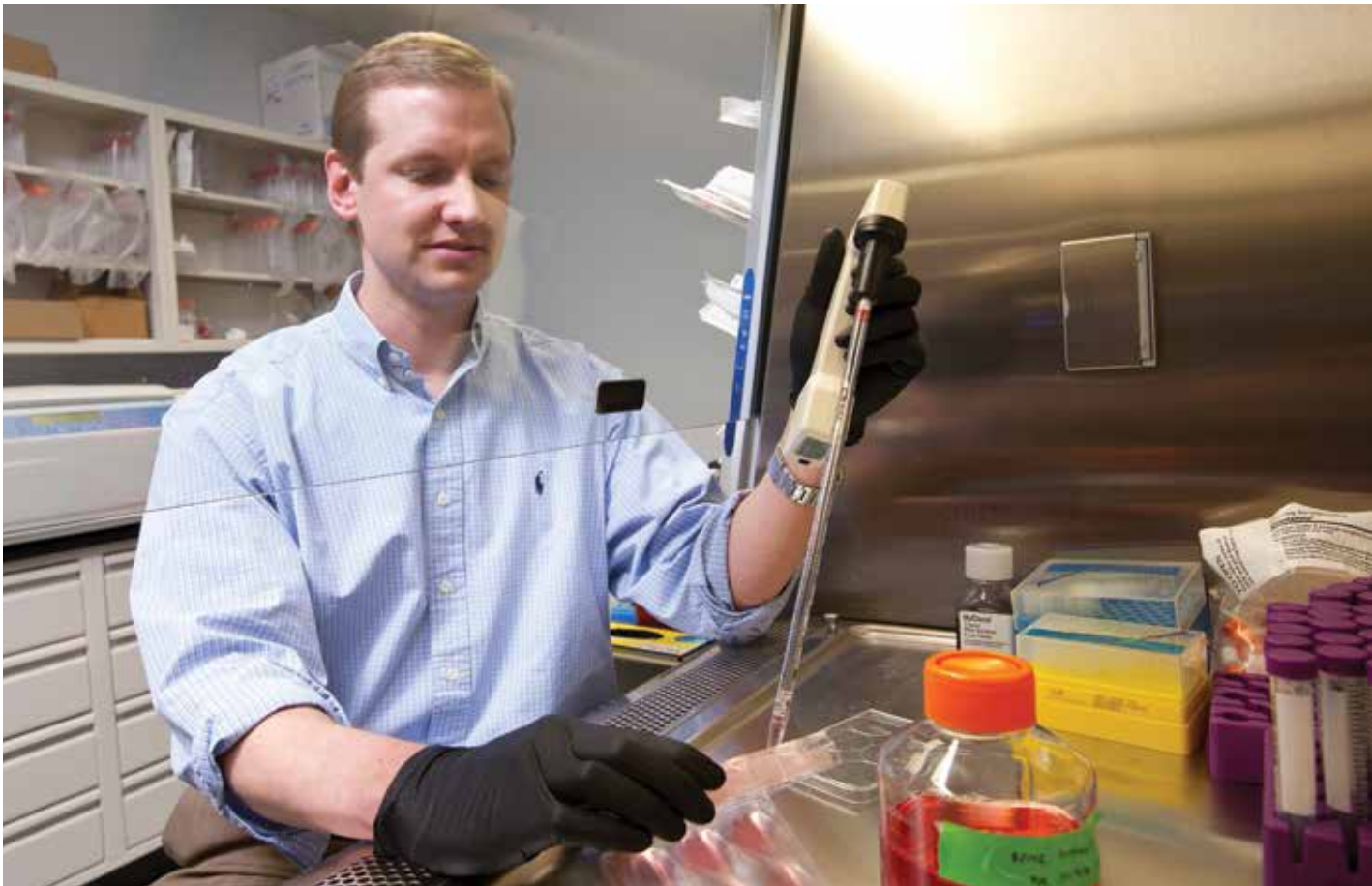
"We tried a lot of different combinations of antigens and cytokines with chitosan," Greiner says. "In the end, IL-12 won the contest." While experimenting with the two substances, Zaharoff and Greiner met Benjamin Hoffman, a post-baccalaureate fellow who was "on loan" from the NCI's Urologic Oncology Branch because he wanted to work with vaccines. Hoffman wanted to test some of the tumor immunology and biology lab's vaccines on superficial bladder cancer. Zaharoff and Greiner decided to collaborate with him and try the chitosan/IL-12 mix on that type of cancer. Both Greiner and Zaharoff emphasize the importance of working within a group of labs. It was this fact, more than the nature of the research itself, that led to the collaboration with Hoffman. In

other words, Zaharoff and Greiner did not co-formulate chitosan/IL-12 specifically for superficial bladder cancer. "Chitosan/IL-12 was designed for direct injections of solid tumors," Zaharoff says. "In retrospect, it made perfect sense to instill it in a bladder." Each year, approximately 70,000 people in the United States are diagnosed with bladder cancer, and slightly more than 15,000 people die due to the disease. For many decades, a drug known as BCG (bacillus of calmette-guerin, a type of bacteria) has been the standard-of-care immunotherapy for superficial bladder cancer, which leads to muscle-invasive and then metastatic bladder cancer. However, a high percentage – 20 to 30 – of patients fail initial BCG therapy, and 30 to 50 percent of patients develop recurrent tumors within five years. Other research groups had worked with IL-12 as a potential alternative therapy for superficial bladder cancer. The drug had shown an ability to eliminate tumors, but a recent clinical study on patients with recurrent superficial bladder cancer was not successful. Working with mouse models, Zaharoff, Greiner and Hoffman designed a study that instilled treatments of BCG, IL-12 or the chitosan/IL-12 co-formulation into the bladder using a catheter. They found that chitosan improved delivery and bio-adhesion of interleukin 12. After four treatments, 88 to 100 percent of mice treated with chitosan/IL-12 were cured, meaning the tumors were eradicated. In contrast, only 38 to 60 percent of mice treated with IL-12 alone were cured. None of the mice treated with BCG alone were cured. "Antitumor responses following chitosan/IL-12 treatments were durable and provided complete protection from tumor re-challenge," Zaharoff says. These results excited Zaharoff, and he was motivated to understand the mechanisms at work. Urinary analysis showed that chitosan/IL-12 had induced multiple cytokines at levels significantly higher than either IL-12 alone or BCG. Tumor analysis following chitosan/IL-12 treatments revealed moderate to intense tumor infiltration by T cells, a group of white blood cells critical to the immune system, and macrophages, also a type of white blood cell. Bladder tissues from cured mice contained residual populations of immune cells that returned to baseline levels after several months.

### What He's Made Of

Although proud of his work at the National Cancer Institute, Zaharoff knew it was time to move on. All along, the plan was to procure an academic position at a university and establish his own lab. Having paid his dues in Schlom's lab, Zaharoff accepted

**Left**, Zaharoff combines chitosan with Interleukin-12, an agent that stimulates the body's immune system to attack cancerous tumors. **Top right**, chitosan/IL-12 mixture. Zaharoff examines a mouse (**center top**) and measures the diameter of a tumor (**center bottom**). **Bottom right**, immune cells infiltrating an injection of chitosan/IL-12.



Photos by Russell Cothen





## Excited to Go to Work

Sometimes the indirect route is the best way to get to where you want to be, even if you don't know exactly where that is. At least you know where you don't want to be. This was how it worked for David Zaharoff. He started as a mechanical engineer. After finishing his bachelor's degree at the University of Illinois, he watched his friends go off to Detroit and other places, where they earned good money. But Zaharoff wasn't inspired by the types of problems – “fuel efficiency, aerodynamics, stuff like that” – that they were solving.

“All my friends went to work at Ford and GM, and they're perfectly happy,” he says. “But I couldn't see myself designing a luggage rack on a minivan. I wanted a bigger challenge.”

Questions he wanted to answer: Why does the human body randomly develop deadly diseases? How does the body respond to different types of biomaterials? Why are most drugs taken orally if they are meant to act at very specific locations within the body? What is the ideal way to treat cancer? These kinds of questions steered him toward biomedical engineering and landed him at Duke.

“These were problems I could identify with, problems that excited me,” Zaharoff says. “Because ultimately you have to be excited to go to work. If not, it makes for a long day.” ■

a position in the rapidly burgeoning biomedical engineering program at the University of Arkansas. He says positions at other institutions were attractive, but Arkansas offered resources and the kind of academic freedom he was seeking to build an eminent lab the way he envisioned it.

“My training phase was over,” he says. “It was time to become an investigator with my own lab and see what I'm made of.”

Without severing ties to Greiner and Schlom's lab, Zaharoff came to the University of Arkansas in early 2009 and immediately began setting up shop in the Engineering Research Center at the Arkansas Research and Technology Park in south Fayetteville. Today the Laboratory of Vaccine and Immunotherapy Delivery occupies approximately 1,900 square feet of space in the Engineering Research Center. Inside the lab, Zaharoff directs and trains a group of researchers, from undergraduates to post-doctoral fellows, who focus on vaccines and delivery systems for several types of cancer, including lung, breast, prostate and myeloma, in addition to bladder. They are also focusing on drug addiction, specifically a new vaccine that can induce the immune system to generate drug-specific antibodies. Zaharoff intends for all of this research to reach clinical trials within five years.

## A New Standard of Care

Or at least be ready for clinical trials. Zaharoff is learning how political that process can be. He and Greiner thought clinical trials testing chitosan/IL-12 on patients with superficial bladder cancer were to begin in 2010, but those studies have been pushed back. He hopes they will begin in 2011, but he understands that these decisions will be made by trial clinicians and others at the U.S. Food and Drug Administration.

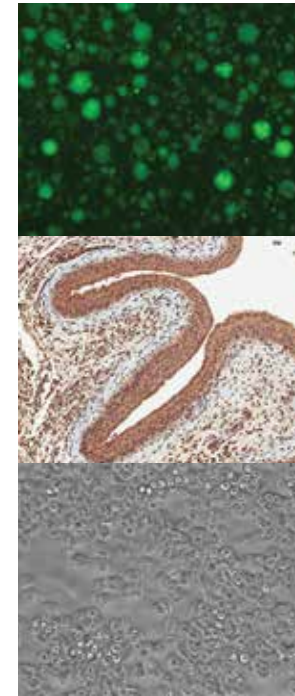
When clinical trials do begin, they will treat patients whose disease has returned after an initial treatment with BCG, the current standard of care. According to Research Support and Sponsored Programs, the university department that manages and tracks all public research funds, it will mark the first time that research from the University of Arkansas – which does not have a medical school – will have reached the medical clinical trial phase.

What are his hopes and expectations for the performance of chitosan/IL-12 in clinical trials? When asked this question, Zaharoff's response is immediate and unequivocal: “I want it to be the new standard treatment of care for superficial bladder cancer.”

## The Colorectal and Pancreatic Study

Zaharoff moves on. He is not the type of person who becomes complacent and waits around for others to gauge the success of his previous work, no matter how promising. For the past year, he and Greiner have applied chitosan/IL-12 to colorectal and pancreatic tumors in mice.

Injections eradicated aggressive tumors. This study also included three types of therapy. In addition to the chitosan/IL-12 co-formulation, the researchers injected IL-12 only and combinations



**Top left**, cancer antigens encapsulated in polymer microspheres. **Center left**, histology and immune cell staining of bladder tissue from cured mice. **Bottom left**, mouse bladder cancer cells growing in culture. **Right**, graduate research assistant Bhanu Prasanth Koppolu uses a flow cytometer to identify changes in immune cell populations.

of chitosan with other cytokines. Administration of IL-12 alone eradicated less than 10 percent of established tumors, but the combination of chitosan/IL-12 caused complete tumor regression. Therapies with chitosan and other cytokines were not successful.

Again, the immune systems of mice were stimulated by the extended presence of chitosan/IL-12 in the tumor microenvironment. Specifically, Zaharoff found that the combination caused significant expansion of CD8+ T-cells and natural killer cells, two types of powerful immune cells. Depletion of these cells stopped anti-tumor activity. However, depletion of other important immune cells, CD4+ and Gr-1+ cells, had no impact on chitosan/IL-12's ability to eradicate tumors.

The colorectal and pancreatic study also revealed the unique power of immunotherapy compared to other methods of treating cancer. Traditional cancer therapies, such as surgery, radiation and chemotherapy, are passive approaches that do not eliminate metastasis after a treatment is stopped. Metastasis, or the spreading of cancer from the original tumor site to other areas of the body via the circulatory or lymphatic systems, is responsible for more than 90 percent of all cancer fatalities. Zaharoff says that chitosan/IL-12 immunotherapy is an active approach that induces a massive immune response capable of “remembering” what a particular tumor cell looks like long after therapy is complete. As a result, if the tumor tries to recur in the same or distant place, the immune system will recognize it and destroy it.

This behavior – the memory and subsequent ability to stimulate the immune system as cancerous cells return – motivates Zaharoff

and Greiner to test chitosan/IL-12 on metastatic cancer. In these cases, Zaharoff proposes to combine immunotherapy with surgery, to inject chitosan/IL-12 into a tumor before it is surgically removed.

## Training the Immune System

With metastatic cancer in mind, Zaharoff has turned his attention to breast cancer, which claims most of its victims after the cancer has spread to other areas of the body. Zaharoff is studying a model in mice in which tumors grow and metastasize in a pattern similar to cancer progression in women. Before surgically removing tumors from female mice, the researchers tested one of several vaccines that are intended to “train” the immune system to find and destroy metastases.

“This immunotherapy is not meant to replace surgery,” Zaharoff says. “In fact, we would still like to see all breast tumors removed. But it gives us a couple of weeks to ‘train’ the immune system before the surgery and thus reduce chances for recurrence or metastasis.”

In addition to the breast cancer study, researchers in Zaharoff's lab are also pursuing projects focused on prostate cancer, myeloma, lung cancer and drug addiction.

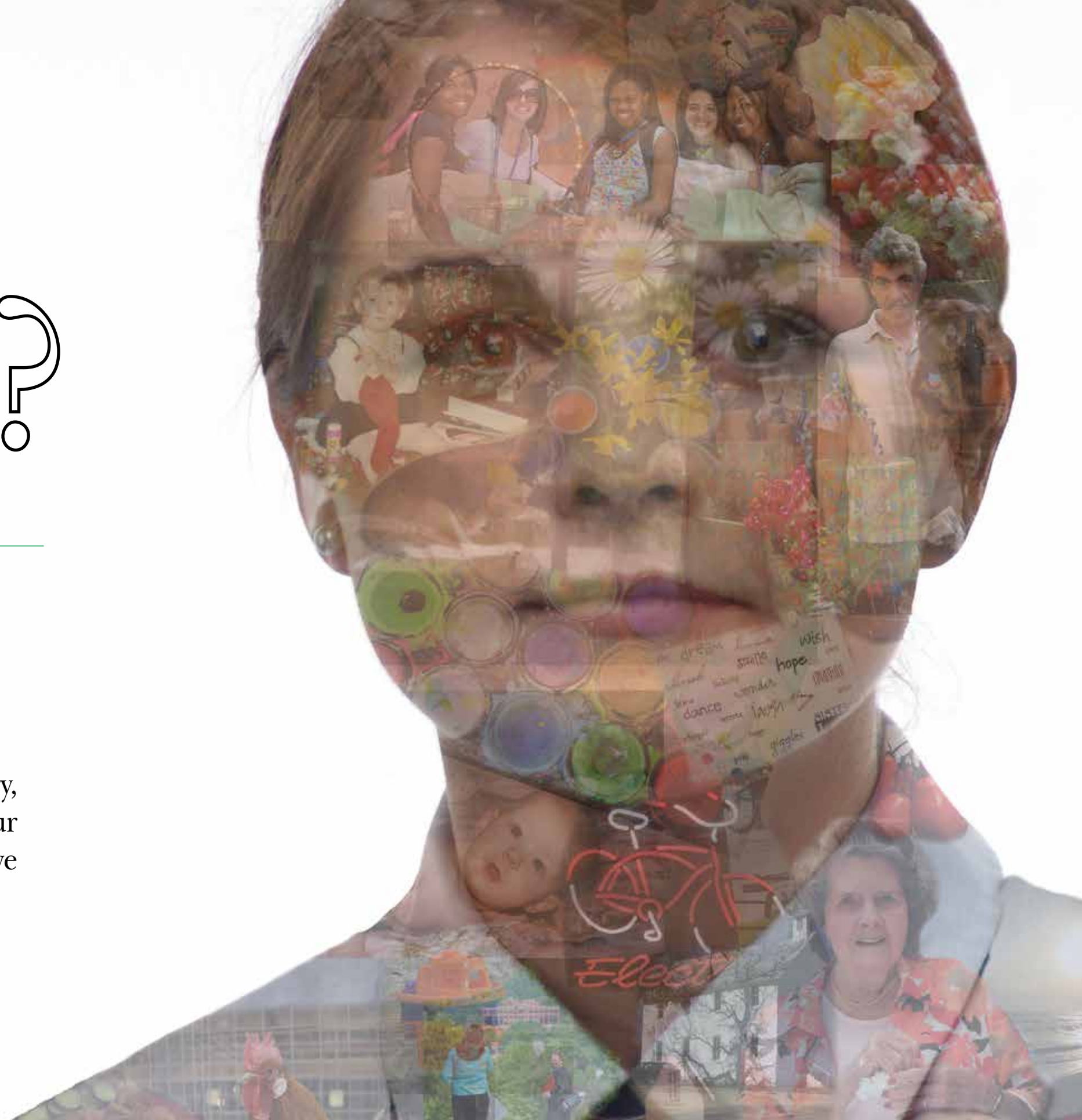
“By no means do we think this therapy is limited to colorectal, bladder and pancreatic cancers,” Zaharoff says. “We think this is a broadly applicable immunotherapy that may be used for the treatment of any injectable solid tumor.” ■



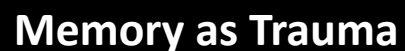
# What's *in* a Memory?

*By Barbara Jaquish*

If you talk very long to psychologists who study memory, big questions arise: Do we make our memories or do our memories make us? Those vivid memories that we all have – did they actually happen? What about false memories?







Those who had attained closure were less likely to be ill or see the doctor in the three months after the attacks. Most attained closure despite being unable to “make sense” of what had happened.

"Sometimes closure just means becoming satisfied with the level of understanding you have," she said.

People who had refused to let the attacks reshape their view of the world recovered more quickly than those who responded by extensively reevaluating their beliefs and perspectives. In fact, those who most successfully coped seemed to defy the idea that the events had changed their lives.

Memories of the September 11 attacks merged autobiographical memory and social event memory. The event was not treated like a memory in which there could be changes over time, but rather like a traumatic event, which was “rehearsed and refreshed with images that people watched over and over,” Beike said.

The constant replaying of video of the attacks was akin to the way images replay in the mind of someone with post-traumatic stress disorder. Although people may choose to re-expose themselves to images in order to reduce the emotional level of the memory and get closure, in reality such an approach doesn't work, Beike said.

"There was nothing positive to be gained from watching those planes hit those towers and watching those towers collapse," she said. ■

Lampinen has studied memory gone wrong – mistaken memories or false memories – and memory focused on future actions, such as remembering the face of a fugitive or missing person.

Beike says there are two sides to this question:

“Are memories influential? Absolutely. But we are not the victims of our memories. We are not the passive recipients of our memories’ influence.”

Rather, Beike makes the case that we are in charge of our memories. People often think about memory as a static video recording that simply gets replayed. In fact, Beike said, memories are “flexible, reconstructed and error-filled.” With mutability comes power.

“Because memories are reconstructed and altered, if you know the healthy or productive or good way to think about things, you have the option to do what you want with your memories.”

In her research in autobiographical memory, Beike has seen people do just that. Autobiographical memory encompasses the simplest early memory of breaking your grandmother's favorite cup as well as personal memories of a day that most people remember, like September 11, 2001.

Memories can either be open or closed. Open memories contain more emotional detail and arouse more agitated emotions than do closed memories. And, emotional content exists with both pleasant and unpleasant memories. Open and closed

memories are not memories of different types of experiences; rather, they are different ways of thinking about or responding to an experience.

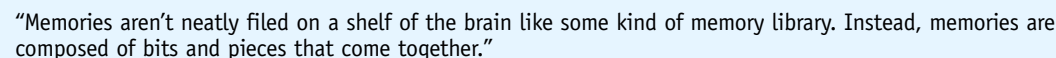
"It doesn't matter how long ago something happened, but if you remember it and it doesn't pull at you emotionally, you have closure on it," she said. "It's under your control. You can choose to remember the emotions or not."

Brain-imaging studies have made this process clearer.

Autobiographical memories aren't neatly filed on a shelf of the brain like some kind of memory library. Instead, memories are composed of bits and pieces that come together in the hippocampus.

"Your brain goes searching within itself for all the little elements of the memory. What smells do I remember? Who was there? What did I see, and what did I hear? Then it bonds them together, and you say 'oh, yes, I remember that day,'"

“  
memories  
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and  
error-filled



Beike explains. "If your brain just decides it's not going to go looking for the emotional pieces, well then there you have it. They're still there, but it just didn't at that moment bring them in."

Closure is just one way people have to elevate or to reduce the importance of an event.

"I think we probably have a whole basketful of coping mechanisms that we don't necessarily think about," Beike said.

One coping mechanism is to shrink or stretch event boundaries, meaning that people can look at an event in a way that makes it more or less closely related to the self. For example, when your friend interrupted you while you were telling a really good story, if that event is remembered as something that happened once on one

day, it has little influence on how you view yourself and your friend. If you expand the boundary of the event to see your friend's rudeness as the latest example of repeated disrespect for you, then the memory has more impact and becomes more focused on you.

Knowing that people have the option to do what they want with their memories is important for psychotherapy, particularly for those who study and treat post-traumatic stress disorder. Beike also sees implications for how people remember “the lumps and bumps of life” as well as the triumphs of life:

“It’s not just that you’re a victim of circumstance and the environment. You can exercise your free will in how you remem-

ber those things, and the mere act of remembering in a different way changes you and changes what you do and changes how well adjusted you are.”

Remembering unpleasant experiences with a sense of closure, Beike says, is the healthy and adaptive way to remember them.

## What about false memories?

In his basic memory research, James Lampinen has looked in two directions: how do people come to have false memories that feel so real, and how do people avoid false memories.

Researchers in Lampinen's lab have looked at false memories that are vivid and detailed, sometimes called phantom





In laboratory experiments, people remember details about a stapler that wasn't there.

recollections. In one experiment, the researchers set up a room that looked like a graduate student's office furnished with the usual office supplies and equipment but no stapler. When researchers tested participants about what had been in the room, people would say they remembered a stapler being in the office. The researchers took this one step farther and asked if they distinctly remembered a detail about the stapler and to describe it.

"A surprising number of people indicated that, yes, they could remember details, such as the size, shape, color and location of the stapler," Lampinen said.

In another experiment, participants listened to a tape of three different people reading a list of words that followed a theme, such as bed, rest, nap, snooze, slumber, all related to the word sleep, but

the word sleep was never presented. When tested, many study participants not only said they'd heard the word sleep, but they identified the speaker who had said it.

Lampinen calls this process "content borrowing." When someone is retrieving a memory, at first the item feels familiar, and that feeling of familiarity leads them to search their memory for details. They recall details from a different but related event that is close enough that it convinces them.

Thus, when the study participants are tested about the sleep-related words, they are borrowing details from other words that convince them that they heard the word sleep and that they can recall the particular person who said the word. In some cases, participants reported remembering the word because it had been said in a strident voice. That was another demonstration of

borrowing. A word had been said in a strident voice, but it wasn't the word sleep.

### Mistaken witnesses

It may not matter whether you remember all the details of a cup you broke. Maybe it was blue, maybe flowered. But in other cases, the details are crucial, and vivid memories may lead you astray. At worst, a false memory could lead to the conviction of an innocent person.

When it comes to mistaken identification in legal situations, Lampinen says there are two issues. First are the factors neither witnesses nor criminal investigators can do anything about, such as distance from the perpetrator and lighting. Also, research has shown that people are better at identifying people of their own race or ethnicity than people of other races or ethnicities. All that can be

done is to inform the jury about these limitations so they can take them into account.

Other factors are under the control of the criminal justice system.

In a line-up that includes a suspect, police will include a certain number of foils, individuals who are not suspects and are known to be innocent. Studies of police records have shown that about 20 percent of the time, witnesses chose one of the foils. And, Lampinen points out, "We know that in one out of five actual criminal cases, witnesses choose an innocent person out of the lineup, because they choose one of the foils. Presumably, some percentage of suspects who are identified are also the wrong person."

If a sufficient number of foils are used, and the line-up is fair, even if witnesses are mistaken in their identification, they are more likely to mistakenly pick a foil

than to mistakenly pick the suspect. The instructions given to the witness can make a big difference. It's been shown that simply telling a witness 'the perpetrator may or may not be in this line-up' substantially decreases the chance of a false identification.

For several years, Lampinen's lab has researched the factors that affect confidence judgments in identification.

"The issue isn't simply that witnesses make mistakes, but that witnesses make mistakes and they're really confident that they're correct," Lampinen said.

The single largest cause of mistaken convictions is mistaken eyewitnesses, Lampinen says. Moreover, in cases where convictions have been over-turned with DNA evidence, around 75 percent of those cases have had a confident eyewitness.

One area Lampinen has studied and

continues to study is the effect of feedback. Witnesses are vulnerable to feedback effect. That is, if a witness makes an identification and gets confirmation – "Yep, that's him. That's the guy." – the witness is more likely to feel extremely confident in the identification and in later interviews to indicate that they were confident all along.

"Confidence is probably created after the fact and is not a direct memory of how confident you were at the time," Lampinen said.

Lampinen plans to continue doing research on eyewitness confidence. For one, he is interested in investigating what happens to a witness's confidence when an unreliable individual, such as a snitch, confirms the identification. He is also doing some basic research on the effect of environmental factors, such as distance, on the accuracy of identification.

His false memory work at this time is focused on developmental work in children, looking at memory monitoring and cognitive control. His study will examine those factors both in terms of brain function as children age and as related to experiences in school or seeing other people use their memory.

### Memory in the future

How will those children Lampinen is studying use their memories in a world in which cameras record every family event and many public streets? Beike says it is a very different world today, with people obsessively clicking their cell phones to record everything. Yet she questions how often people actually go back to all those photos.

"Even if we have the recorded information, we won't necessarily access it," she said. "After all, we have our own memories to tell the story for us." ■

“The issue isn't simply that witnesses make mistakes, but that witnesses make mistakes and they're really confident that they're correct.”



## The Faces of Missing Children: Tips to Improve Recall

With prospective-person memory, people see a picture of a fugitive or of a missing child and try to remember the face, try to become eyewitnesses in the future. In the favorable conditions of a lab study, 20 to 60 percent of participants spot the missing person. In real-life field studies, the rate plunges to 3 percent. In research conducted at grocery stores, few customers could identify the faces of missing children right after leaving the store.

James Lampinen suggests two simple things people can do to improve their memory for the faces of missing children. First, he suggests, people should take a few minutes to look at the photos of missing children during the next visit to the supermarket, engaging in what is called "implementation intention."

"Previous research has shown that if you repeat an intention to yourself three times out loud, you can dramatically increase doing whatever it is you intend to do," Lampinen said.

Lampinen suggested that people look at the faces in the posters holistically.

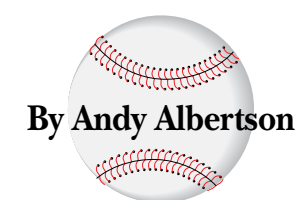
"One mistake we sometimes make is to try to memorize a face in the same way we memorize a string of words," Lampinen said. "A string of words you can memorize one word at a time. With a face, you can't just remember the eyes and then the nose and then the mouth. Rather, faces are best remembered as perceptual wholes. You have to take it all in. And, try to picture the child's face in different situations." ■





Rule 6.10

# Baseball's Great Debate



By Andy Albertson

We all know the old saying, “Don’t talk about politics or religion.” Whoever came up with it must not have known any baseball fans, because surely she would have added “or the designated hitter rule.”

Since 1973, Major League Baseball has seen its two leagues, the American League and the National League, play a slightly different form of the same game. The source of this discrepancy is the designated hitter rule. In the National League, the pitcher does his own batting. In the American League, a skilled hitter takes the place of the pitcher in the batting lineup.



To most people, this probably doesn't sound like a big deal. To a baseball fan, a calm, rational discussion of the designated hitter rule can escalate quickly into an argument, shouting, hurt feelings, fisticuffs, or worse. As a writer for *Sports Illustrated* once put it, "probably not since the Roman Catholic Church switched from Latin to English Masses has any break with tradition caused more vigorous argument in this country."

University of Arkansas law professor Dustin Buehler and University of Washington law professor Steve Calandrillo brave the waters and attempt to settle the debate once and for all in their article "Baseball's Moral Hazard: Law, Economics, and the Designated Hitter Rule," published in the *Boston University Law Review*. The article paints a detailed picture of the debate and then takes a law-and-economics approach to settling it.

So, how did Major League Baseball come to operate under two sets of rules? In the late '60s and early '70s, baseball was dominated by pitching. Runs were hard to come by, especially in the American League. Fans shied away, and in the 1972 season, the National League outdrew the American League by four million fans. Hoping to increase scoring and attendance, in 1973, the American League adopted the designated hitter rule on a three-year trial basis.

The new rule was so successful in bringing offense and fans back to the American League that the League voted to make the change permanent in the 1976 season. National League fans decried the rule as disrespectful to baseball tradition and claimed it took the strategy out of the game. American League

fans flocked to the stadiums to watch the runs pile up.

Buehler and Calandrillo's article focuses on another aspect of the debate – does the designated hitter rule create a moral hazard? A moral hazard exists when a person behaves in a risky way because he doesn't fear retribution. One risky, often rewarding, thing a pitcher can do is throw inside (close to the batter) to open up more of the strike zone or to simply hit the batter with a pitch. Hitting a batter grants a walk but often saves a run. And, it can sometimes lead to injuries or even bench-clearing brawls. In addition, hitting a batter with a pitch often results in the other team's pitcher serving up retribution by hitting a player on the other team.

In the case of the designated hitter rule, it has been demonstrated that American League pitchers are more likely to hit batters with their pitches, in part because the pitchers do not have to worry about being hit with a pitch themselves since they won't be batting. On average, American League pitchers have been 10 to 15 percent more likely to hit batters, and by 2004, the National League has exceeded the hit-batter rate only four times in 31 seasons. This suggests that the designated hitter rule has created a moral hazard.

Though the discrepancy between hit batsmen in the National League and American League is shrinking due to factors such as league expansion and the "double warning" or "one free hit" rule, Buehler and Calandrillo conclude there is clearly a cost to the designated hitter rule, namely, the moral hazard it creates. To settle the debate, they use a cost-benefit analysis. In other

words, do the benefits of the rule outweigh the moral hazard effect?

One of the most obvious benefits is increased offensive production. According to the article, "during the first four seasons after implementation of the rule, the American League averaged 1,640 more runs, 202 more home runs, and 19 more points in batting average, compared with the 1972 season. Indeed, the American League has led the National League in overall batting average every year since the adoption of the rule." The increased offense has in turn increased attendance dramatically in the American League.


Another benefit of the designated hitter rule is that it prolongs the careers of popular players, which also drives attendance and allows for gradual recovery from injury. All-time greats like Hank Aaron and Ken Griffey, Jr., were able to continue playing even after age and injury had taken their toll on their bodies, by moving into the designated hitter role. The rigors of fielding are taken out of the equation, which also helps players who are recovering from injury. As the article points out, "After Mariners slugger Edgar Martinez suffered hamstring and knee injuries in 1993 and 1994, he came back as a designated hitter and made the All-Star roster in 1995, while batting an impressive .356 at the plate."

The article also examines a frequent complaint about the designated hitter rule, that it lessens the strategy involved in baseball by eliminating the need for the manager to choose between letting his pitcher hit in a close game or bringing in

a pinch hitter. On the surface, this appears to be a cost of the designated hitter rule, but Buehler and Calandrillo find that this is not necessarily the case. In fact, it might make pitching decisions more difficult for managers. As former Angels manager Bobby Winkles said, "It was a great help when the pitcher used to bat because, even if you weren't sure if he was tired, if he was up and you had a man on and were down by a run, you'd take him out. Now you try to make sure he's tired and you might go just one man too long."

Given the low incidence of injury from batters being hit by pitches and the bench-clearing brawls that sometimes accompany hit batsmen, the article concludes that this cost, while serious, does not outweigh the benefits the American League enjoys as a result of the designated hitter rule.

So, if it works for the American League, wouldn't it work for the National League? Not so fast. The article finds that the cost-benefit analysis would be different for the two leagues for a simple reason – National League fans have different preferences than American League fans.

As Buehler and Calandrillo conclude their article: "American League fans enjoy the increased offense that the designated hitter rule provides. National League fans enjoy pitching duels and the chance to see the manager struggle with the decision whether to pinch-hit for the pitcher in close games. Thus, this may be an instance in which fans should agree to disagree. As long as fans in each league are satisfied with the game under the existing rules, let's play ball (and pass the Cracker Jacks)." 

# Rule 6.10

Any League may elect to use the Designated Hitter Rule.

(a) In the event of inter-league competition between clubs of Leagues using the Designated Hitter Rule and clubs of Leagues not using the Designated Hitter Rule, the rule will be as follows:

1. In World Series or exhibition games, the rule will be used or not used as is the practice of the home team.
2. In All-Star games, the rule will only be used if both teams and both Leagues so agree.

(b) The Rule provides as follows:

- A hitter may be designated to bat for the starting pitcher and all subsequent pitchers in any game without otherwise affecting the status of the pitcher(s) in the game.
- A Designated Hitter for the pitcher must be selected prior to the game and must be included in the lineup cards presented to the Umpire in Chief.
- The designated hitter named in the starting lineup must come to bat at least one time, unless the opposing club changes pitchers.
- It is not mandatory that a club designate a hitter for the pitcher, but failure to do so prior to the game precludes the use of a Designated Hitter for that game.

- Pinch hitters for a Designated Hitter may be used. Any substitute hitter for a Designated Hitter becomes the Designated Hitter. A replaced Designated Hitter shall not re-enter the game in any capacity.
- The Designated Hitter may be used defensively, continuing to bat in the same position in the batting order, but the pitcher must then bat in the place of the substituted defensive player, unless more than one substitution is made, and the manager then must designate their spots in the batting order.
- A runner may be substituted for the Designated Hitter and the runner assumes the role of Designated Hitter. A Designated Hitter may not pinch run.
- A Designated Hitter is "locked" into the batting order. No multiple substitutions may be made that will alter the batting rotation of the Designated Hitter.

- Once the game pitcher is switched from the mound to a defensive position this move shall terminate the Designated Hitter role for the remainder of the game.
- Once a pinch hitter bats for any player in the batting order and then enters the game to pitch, this move shall terminate the Designated Hitter role for the remainder of the game.
- Once the game pitcher bats for the Designated Hitter this move shall terminate the Designated Hitter role for the remainder of the game. (The game pitcher may only pinch-hit for the Designated Hitter).•
- Once a Designated Hitter assumes a defensive position this move shall terminate the Designated Hitter role for the remainder of the game. A substitute for the Designated Hitter need not be announced until it is the Designated Hitter's turn to bat.





**African Americans in Georgia:  
A Reflection of Politics and  
Policy in the New South**

Edited by Pearl K. Ford  
Mercer University Press

In the New South, access to voting has been cited as a measure of progress. But look at other factors and a different story emerges, according to political scientist Pearl K. Ford.

Ford brought together essays by diverse scholars for a comprehensive study of politics and public policy issues with implications for African Americans in Georgia. Chapters examine the systemic barriers to political representation and the public policies that adversely impact quality of life for African Americans.

Ford introduced the volume with discussion of Georgia in the New South. The idea of a New South attempts to separate the South of today from a history of racial violence and an economy dependent on slavery and later on the exploitation of people of color. Georgia, she wrote, is known as progressive because of the dynamics of the metropolitan area of Atlanta.

However, electoral gains have not necessarily translated to equity in education, health and criminal justice. The ninth most populous state, Georgia's economy is among the largest in the country. Yet, it ranks 40th in overall health status, and African Americans bear the brunt of the burden of poor health and limited access to health care.



**Mammal Teeth:  
Origin, Evolution, and Diversity**

Peter Ungar  
Johns Hopkins University Press

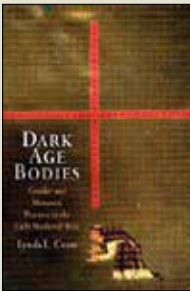
Few people think about the 400 million years of evolution that took place before they could chomp on a carrot, but anthropologist Peter Ungar does, and he's written a book about it.

First Ungar looks at why mammals developed teeth in the first place. He examines the tension between the feeder and food. Developing teeth meant being able to fracture food into easily digestible pieces and allowed mammals to survive in cold climates and become active at night.

The section discusses how teeth have evolved through the ages. The first tooth-like structures date back half a billion years. Ungar looks at the evolution of jaws, teeth, chewing muscles and the bony palate that separates chewing and breathing.

He also explores "early experiments," or animals with unusual tooth formations that don't have any descendants alive today, like the saber-tooth tiger.

Finally, Ungar provides a "who's-who" of the mammalian tooth world, offering up, a summary of the basic ecology of groups, where they live, what they eat, and a tooth-by-tooth description of the mouth of a representative species. This description includes hand-drawn illustrations, which Ungar drew from museum specimens all over the world.



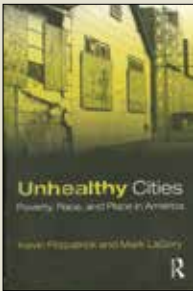
**Dark Age Bodies: Gender and Monastic  
Practice in the Early Medieval West**

Lynda L. Coon  
University of Pennsylvania Press

In this book, history professor Lynda L. Coon reconstructs the gender ideology of monastic masculinity through an investigation of early medieval readings of the body.

Focusing on the Carolingian era (ca. 751-987), Coon evaluates the ritual and liturgical performances of monastic bodies within the imaginative landscapes of same-sex ascetic communities in northern Europe. She demonstrates how the priestly body plays a role in shaping major aspects of Carolingian history, such as the revival of classicism, movements for clerical reform and church-state relations. Carolingian churchmen consistently exploited monastic constructions of gender to assert the power of the monastery.

Focusing on the body, architecture and ritual practice, the book draws from visual and textual materials, including poetry, grammar manuals, rhetorical treatises, biblical exegesis, monastic regulations, hagiographies, illuminated manuscripts, building plans, and cloister design. *Dark Age Bodies* brings together scholarship in architectural history and cultural anthropology with works in religion, classics and gender to present a reconsideration of Carolingian culture.



**Unhealthy Cities: Poverty, Race, and  
Place in America**

Kevin Fitzpatrick and Mark LaGory  
Rutledge Press

Place matters when it comes to health, according to sociologist Kevin Fitzpatrick.

In *Unhealthy Cities*, Fitzpatrick and co-author Mark LaGory of the University of Alabama at Birmingham drew from the social sciences and public health fields to examine the role that place and policy play in the health of Americans.

In urban areas, a single zip code digit can make a big difference in life expectancy. More than 9 million people live in more than 3,000 high-poverty neighborhoods in the United States.

Studies have established a relationship between a concentration of fast-food restaurants in poor, predominantly minority neighborhoods and health problems among residents. These neighborhoods may not have one grocery store offering nutritious food or safe places to exercise.

In the conclusion, Fitzpatrick and LaGory note that cities in the United States have become increasingly unhealthy over the past 50 years.

"Without a comprehensive place-based strategy to address the health needs of the at-risk, underserved, and unprotected in the urban core," they wrote, "America will continue to be a society plagued by the contradiction of great wealth and mediocre health."



**Remembrances in Black  
Personal Perspectives of the African  
American Experience at the University  
of Arkansas 1940s-2000s**

Charles F. Robinson II  
and Lonnie R. Williams  
University of Arkansas Press

With the admittance in 1948 of Silas Hunt to the University of Arkansas Law School, the university became the first southern public institution of higher education to officially desegregate without being required to do so by court order. The process was difficult, but an important first step had been taken. Other students followed in Silas Hunt's footsteps. *Remembrances in Black* is an oral history that gathers the personal stories of African American faculty, staff and students at the state's flagship institution.

These stories illustrate the anguish, struggle, and triumph of individuals who had their lives indelibly marked by their experiences at the school. Organized chronologically over 60 years, this book illustrates how people of color navigated both the evolving campus environment and that of the city of Fayetteville in their attempt to fulfill personal aspirations. Their stories demonstrate that the process of desegregation proved painfully slow to those who chose to challenge the forces of exclusion. Also, the remembrances question the extent to which desegregation has been fully realized.



**Sex, Violence, and the Avant Garde  
Anarchism in Interwar France**

Richard Sonn  
Pennsylvania State University Press

In this book, history professor Richard Sonn argues that by the end of World War I, the conflict between anarchism and the state had been eclipsed by the competing forces of liberalism, fascism and communism.

To combat their slide into irrelevance, French anarchists, especially those called individualists, redirected their attentions from violent revolution and general strikes to ethical issues that focused on personal liberation. Chief among these issues was sexual freedom, meant not only for the sake of pleasure but to undermine the authoritarian family, bulwark of the patriarchal state.

Sonn approaches the French anarchist movement during this period from a socio-cultural perspective, considering the relationship between anarchism and the artistic avant-garde, political violence and terrorism, sexuality and sexual politics, and gender roles. He shows that, anarchism in theory and practice played a significant role in the culture of interwar France.

Martin Jay of the University of California, Berkeley says, "Drawing on a wealth of new sources and a lifetime immersion in the history of European anarchism, Richard Sonn has fashioned a fresh and arresting account of the libertarian and libertine left in France between the wars."



## Why Has There Been A Seeming Sudden Upsurge of Bed Bugs?

*Allen Szalanski, professor of entomology in the Dale Bumpers College of Agricultural, Food and Life Sciences, replies:*

Since the late 1970s, bed bugs have undergone a resurgence that became widespread in the late 1990s, and it seems to be global across the developed world. Reasons for this resurgence may include increased long-range airline travel, the ability of bed bugs to disperse locally, reduction in the use of residual insecticides around structures, and movement of bed bugs from birds and bats to humans. Our research has revealed that bed bugs in Arkansas are highly resistant to DDT. We also have found that human DNA can be recovered from bed bugs for up to 90 days, and this DNA could then be used for forensic purposes.

## What Causes Soda Pop to Fizz? And Why Does it Lose its Fizz?

*Bill Durham, professor and chair of the department of chemistry and biochemistry, replies:*

Carbonated beverages are prepared by dissolving carbon dioxide gas in the water that makes up the bulk of most beverages. Carbon dioxide is not very soluble in water and only a small amount will dissolve naturally. This amount is not sufficient to alter the taste or provide fizz. However, if the carbon dioxide is forced into the liquid by increasing the pressure of the carbon dioxide in the container, much more will dissolve. The pressure used is around 100 pounds per square inch. As long as the pressure is maintained, the carbon dioxide will remain dissolved. When the cap of a carbonated beverage is removed, the pressure of carbon dioxide over the beverage is reduced to almost zero. Under these conditions, the carbon dioxide becomes less soluble in the beverage and it will be released. The process of releasing the gas can be slow or fast. Once all of the carbon dioxide is released, the beverage becomes flat and contains about the same amount of carbon dioxide it would if we just allowed the carbon dioxide naturally in the atmosphere to dissolve in the beverage.