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Winter 2009

Odyssey

It Pays to Be a Cheapskate

Making capacitors
from throw-away plastic



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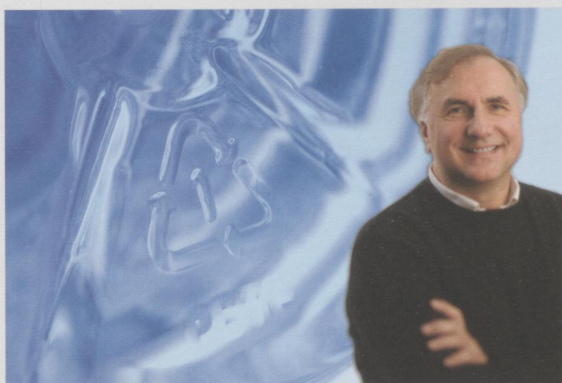
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COVER STORY



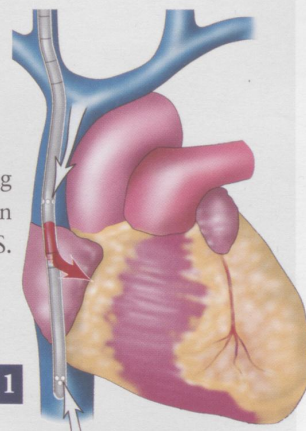
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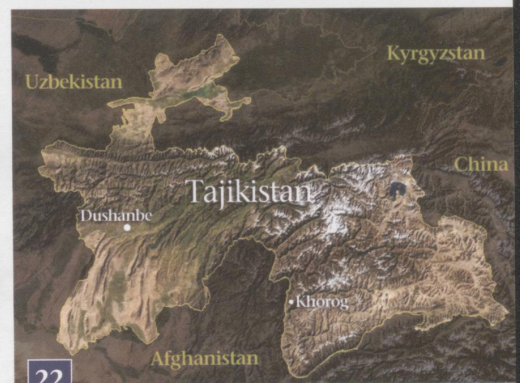
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Steve Lipka, a senior research associate at the Center for Applied Energy Research, is creating electrochemical capacitors—tiny battery-like devices that give quick bursts of energy—from cheap sources of carbon like plastic bottles. Lipka's team grinds up PET bottles, the most recycled type of plastic, and turns them into capacitors.

It Pays to Be a Cheapskate

Making capacitors from throw-away plastic

By Alicia P. Gregory

As Steve Lipka describes the cool ways people on the other side of the globe are using capacitors, tiny battery-like devices that give quick bursts of energy, my first thought is “same old story. The U.S. lags behind the rest of the world again.” Unfortunately, in talking to scientists about alternative energy, I’ve heard this refrain more than a dozen times. He tells me predictably that from camera phones to BMWs to cargo cranes, Europe and Asia lead the world in using capacitors to improve technology and save energy.

But the good news is that Lipka, and by extension the University of Kentucky’s Center for Applied Energy Research (CAER), earned a prominent place on the global stage thanks to a research initiative of one of the world’s

leading energy companies, E.ON. In 2007 when E.ON, based in Germany, called for the best energy storage ideas, Lipka competed with scientists from more than 50 universities and institutes from 11 countries. Of the 10 projects chosen, Lipka’s was the only one from the United States, and he netted nearly \$1.2 million to expand his research on carbon capacitors.

What set Lipka apart? He’s a cheapskate. He wants to use cheap sources of carbon (like rayon, coal byproducts and plastic bottles) to build the next generation of capacitors for an array of applications, including storing energy from the sun and wind. So here’s what I want to know: Why are capacitors better than batteries? What are capacitors good for? And how do you make a “green” capacitor?

Capacitors vs. Batteries

"We need to talk a little bit about capacitors versus batteries," Lipka says, leaning against a table in his windowless, second-floor lab at CAER where he's worked as a senior research associate since 2003. Capacitors and batteries both store ions, negatively or positively charged molecules, he says, "but capacitors beat batteries hands-down when you talk about high-power density—rapid charge and discharge. Capacitors release energy in a quick burst. Batteries, on the other hand, have high energy density—can store a lot of energy and give sustained power over a long period of time—but they're not good at giving high-power bursts."

Why? "It all has to do with kinetics—the way the ions move," he explains. "Batteries store energy chemically. It's less efficient than electrostatic storage—the way capacitors do it—because the phase changes that battery materials go through happen slowly."

"The life of a battery is very dependent on the way you charge and discharge it. For example, if you're unlucky you might get three years out of the lead-acid battery in your car. Lucky, five to 10. Now you say, 'That's a pretty good length of time.' The battery works just fine because you are discharging only a small fraction of the total energy it holds. But if you took that brand-new battery, removed all of the energy, then put all of the energy back in, you'd only be able to do that about 500 times; then it would die."

The current market for capacitors is roughly \$400 million a year. "But if we could bring down the cost of capacitors, that market could explode," Lipka says, estimating that \$2 billion is not outside the realm of possibility.

"If you want energy for a sustained period of time, batteries are the way to go. If you want to have energy delivered for a short burst period of time, capacitors are your choice."

Capacitors 101

So how do they work? "Both capacitors and batteries have two electrodes in a liquid solution called an electrolyte. One of the electrodes is charged positively and the other negatively, so the positive ions in the solution go to the negatively charged electrode and vice versa."

Just like AAA- through D-cell batteries, capacitors come in a range of sizes and two basic shapes. The first, Lipka tells me, looks like a jelly roll. The electrode plates are rolled up with a layer of electrolyte. The second, like the lead-acid battery in your car, is "prismatic," a flapjack-like stack of electrodes and electrolytes.

"I work on asymmetric carbon-based electrochemical capacitors," Lipka says, expertly navigating that tongue twister.

"People are fascinated by electrochemical capacitors because of their ability to store large amounts of charge," he says, adding that the amount of charge a capacitor stores is proportional to the surface area. "The theory is, the greater the surface area, the more charge I can store."

He tells me that the reason carbon makes such good capacitors is that with minimal effort (say, a little steam or an added chemical plus heat) you can create tiny pores, into which ions can fit. He explains that you don't want pores that are too big or the ions—the charge—isn't stored efficiently. The same goes with pores that are too small (less than a nanometer).

"Some years ago in Russia, scientists discovered that instead of using two carbon-based electrodes, if you replaced one of those with a battery-type electrode—a metal oxide that uses chemical storage of energy—you could increase the voltage of the capacitor. 'Asymmetrics' give you the best of both worlds," Lipka explains, bringing us back to the first word in the capacitor tongue twister.

He says an aqueous carbon-carbon electrode capacitor (with a water-based electrolyte) yields about 1 volt. If you use a lead dioxide-carbon electrode combo, you get 2.1 volts. "We're trying to find clever ways to increase the energy density

of capacitors—we're shooting for 3.5 volts or more." There's a twinkle in his blue eyes as he tells me, "It's not rocket science. We try to keep things as simple as we can."

"The E.ON grant is funding our work on unique material chemistries no one else has looked at before. One of our asymmetric options is part high-surface-area carbon and part lithium-ion battery." Lithium-ion batteries (the hottest battery technology out there) are much smaller and six times more powerful than a lead-acid battery.

Lipka is testing these new chemical combinations on a small scale in his lab. (See "Green to Go" on page 6 to learn how he makes a capacitor from rayon fiber.) By building his tiny test capacitors, Lipka is leading the way to the next generation of products for tomorrow's hybrid cars and a green-energy-based electric utility grid.

What Are They Good For?

You'd have to be living under a rock not to have noticed the rise of hybrid cars. Toyota's premier hybrid, the Prius, is what Lipka calls a "full" hybrid. "It's got an internal combustion engine, an electric motor, and batteries that can be charged and discharged to run that motor."

But I learn there are other types of hybrids, which use the power of capacitors. "Micro-hybrids are getting attention now in Europe." (Lipka defines a micro-hybrid as a vehicle in which the electric components do not contribute to the propulsion drive-train, but instead act as a generator.) For those who don't want to trade

Not only are capacitors vastly more efficient at storing energy recovered from braking, they trump batteries in terms of lifetime. "You could put a capacitor in a vehicle, charge it to its full capability and discharge it fully, and it'll outlive any car."—Steve Lipka

horsepower for better gas mileage, BMW is working on a micro-hybrid that conserves fuel by coupling a regular internal combustion engine with a large starter motor that's powered by an electrochemical capacitor.

A system called "auto stop-start" shuts off the engine automatically whenever the car comes to rest and is taken out of gear—for example, at traffic lights—and restarts it the second you hit the clutch pedal or accelerator, saving fuel and reducing emissions.

Lipka says a British study has shown that if every New York City taxicab were replaced with an auto stop-start vehicle, we'd save 10.8 million gallons of gas per year and 105,000 tons of CO₂ emissions.

"All of the new 1, 3 and 5 series BMWs, as well as the Mini Cooper, are going to use this auto stop-start system, with capacitors supplied by a San Diego company."

When I ask how the capacitors get their charge, Lipka smiles and says, "That's the cool part. They call it 'BERS'—Braking Energy Regeneration System. The energy that you use for braking is recovered and charges up the capacitor again so it can be used the next time the motor needs to be fired up."

"In the Prius, braking charges up the batteries, but the capture efficiency is very low. Batteries can't capture and store all of that energy because it's chemical storage of energy versus electrostatic storage."

Not only are capacitors vastly more efficient at storing this recovered energy, they trump batteries in terms of lifetime. "You could put a capacitor in a vehicle, charge it to its full capability and discharge it fully, and it'll outlive any car. "And this is the feature that'd be most beneficial in using large capacitor banks to store energy on an electric utility grid. You could have a system that would last 30, 40 or more years."

Lipka reminds me that our outdated power grid system doesn't allow us to tap into potential green energy sources. "We'd love to use green, clean energy like solar and wind power, but when you're at the mercy of Mother Nature, you can't rely on those sources to produce continual power." But what if we could harvest those sources, store that energy, and deliver it when there are power outages?

Continued on p.6

6 Cool Things to Do with Capacitors

Run car audio systems

One of the first widespread applications for capacitors, automotive aftermarket sound systems use these compact power sources to run subwoofers that provide thumping base.

Pitch wind turbine blades

As the wind blows in different directions, the wind turbine blade adjusts its pitch to run more efficiently. These pitch adjustments used to be controlled by lead-acid batteries, but now are performed by banks of highly efficient electrochemical capacitors.

Power LED camera flash

An Australian company is making a capacitor (slightly longer and thinner than a quarter) that fits inside a cell phone to power a tiny LED flash. The better illumination provided by this flash creates higher quality photos with the phone's built-in camera.

Save fuel for shipyard cargo cranes

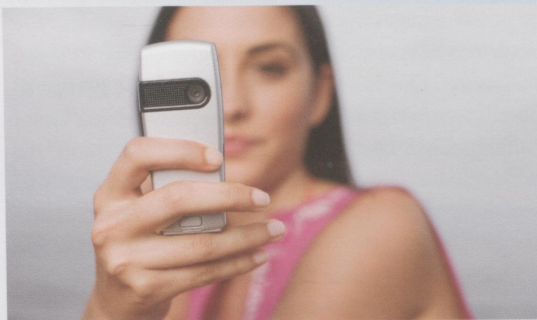
Rubber tire gantry cranes—the rolling behemoths that raise containers from cargo ships and lower them onto railcars or tractor trailers—consume a lot of diesel. A Japanese company designed a hybrid crane that uses the kinetic energy of the lowering motion to charge a capacitor to lift the next load. These cranes use half the fuel and have much lower emissions than traditional cranes.

Save gas with auto stop-start

BMW is leading the world with a hybrid vehicle that couples a regular internal combustion engine with a large starter motor powered by a capacitor. The auto stop-start system shuts off the engine automatically whenever the car comes to rest—for example, at traffic lights—and restarts it the second you hit the accelerator, saving fuel and reducing emissions.

Back-up electric power grid

Nearly 80 percent of all power outages are 5 seconds or less in duration. Capacitor banks, which could store wind or solar power, could deliver electricity to efficiently cover these outages. Capacitors can also be used for voltage stabilization (supplement in times of heavy usage).



Lipka gives an interesting stat: “Nearly 80 percent of power outages are of 5-second duration or less. You don’t need expensive batteries to give power in those instances.” Quick-burst capacitors would be perfect to cover those outages. They could also provide what Lipka calls “ride-through” power—sustained electricity for critical industries where even a momentary outage can wreak havoc on equipment or shut down an entire assembly line.

Lipka also says great potential lies in linking up batteries and capacitors, and that potential is evidenced by a project he’s working on with funding from the Office of Naval Research. Naval personnel and Marines use a pulse-based communication system. “When you talk or you send or receive information, the system transmits a high-power pulse—and right now a battery sends that pulse.” Like Lipka has explained, and I’m beginning to understand, the chemical energy storage in batteries isn’t geared to quick power bursts, so repeated pulses make the batteries die prematurely. “What we want to do is shrink the size of that battery by coupling it to a capacitor. The capacitor will handle the pulses, and the battery will live a much longer and productive life.”

Green to Go

Both the Office of Naval Research and E.ON projects require Lipka to make the most “energy-dense” carbons he can. He says that means packing as many farads (the measurement of electric charge stored) per gram into his capacitors as possible. “The best commercial carbon materials right now are on the order of 100 farads per gram,” he says, and with a wry smile, continues, “Like everybody else out there, our goal is to blow that out of the water. But the key to our approach is that we want to create carbons based on low-cost starting materials and with low-cost processing methods.”

Lipka’s covered a number of cheap materials so far. He’s made carbon from rayon fiber. “The biggest market for rayon is, of course, clothing. We’ve linked up with the world’s largest producer of rayon fiber, a company in Austria.” Rayon, which is made from cellulose (the structural part of the cell wall in plants), is “green.” Well, actually it’s white. In fact, as he pulls a large bag of rayon out from under the table in his lab and gives me a handful, it looks a lot like wool and feels soft and fuzzy.

Lipka takes rayon through a couple of processing steps to convert it to a porous carbon and then into electrodes. The first steps involve heat. With a handful

How to assemble a bargain-basement capacitor

CAER carbon materials scientist Chris Swartz starts with current collectors (1) made from a carbon-filled polymer and the rayon-based, activated carbon discs

(2). He presses a carbon disc onto the current collector (3) to create one electrode. Then Swartz adds the separator (4).



of rayon, Lipka says, "If we tried to heat up this fuzzy stuff, it would melt. So first we go through what we call the stabilization/oxidation step at a relatively low temperature—190 to 230 degrees Celsius—that stabilizes the material in an oxygen-rich atmosphere. It starts to turn black at that point.

"The next step is carbonization. The high temperature, around 850°C, strips away some of the non-carbon atoms and reorients the carbon atoms, a process which improves the conductivity. Then comes the activation step—by exposing the rayon to CO₂ or steam at high temperature, we make high-surface area carbon with lots of tiny pores."

He hands me a baggy filled with pitch-black rayon. Funny, it still looks fuzzy. When I point this out, Lipka says, "Yeah, it retains its fiber form. So we just chop it up, grind it into a powder, add a small amount of conductive graphite, and mix in 3 percent Teflon powder."

Why Teflon?

Lipka says the Teflon forms tiny fibrils, like a spider's web, that hold the material together so he can roll it out in a very thin sheet. (It's like a much thinner version of aluminum foil that's matte black.) Then with a tool, not

unlike a paper hole punch, he pops out 10 millimeter discs. These tiny black discs, coupled with "current collectors" made from a carbon-filled polymer, and an insulating ring create one electrode.

Lipka says to make a working electrochemical capacitor you'd just repeat this process to make another electrode and then put a separator between them. The separator, made from a tiny disc of shiny white material, also punched out of a big sheet, serves three purposes. It holds the electrolyte (tiny pores soak up the electrolyte like a sponge), provides ionic conduction (allows the free movement of ions between electrodes), and prevents the electrodes from shorting out.

Lipka's colleague, carbon materials scientist Chris Swartz, sandwiches the electrodes between two larger metal discs welded to wire leads, attaches these leads to an electronic box linked to a computer, and runs a series of tests. This is how Lipka's team screens materials to determine which cheap sources offer the best power performance. "The rayon material is our best option so far, interestingly," Lipka says, adding that he's filed a number of patents on this process and is working on ways to further boost the energy density.

He injects this tiny white disc with the liquid electrolyte (5), then repeats the process to make another electrode and stacks them to create a capacitor (6). He then sandwiches the capacitor between two larger metal discs welded to wire leads (7), attaches these leads to an electronic

box (a potentiostat) linked to a computer (8). By running a series of tests, Steve Lipka's team can screen materials to determine which offer the best power performance.





"We've achieved 143 farads per gram with activated rayon fiber." He says that two other labs have achieved 150 farads per gram with carbons produced with exotic metals and a much more expensive activation process.

Lipka's also turned coal, both bituminous (Kentucky coal) and anthracite (Pennsylvania coal), into a porous carbon for electrodes. And, maybe most exciting of all if you're worried about all of those plastic drink bottles clogging our landfills, Lipka's got undergrad students grinding up PET bottles (the most recycled type of plastic bottle) and converting them to high-surface area carbon in a simple two-step process. "We tested the energy storage of these materials in our capacitors and found they hold almost 100 farads per gram. Think of how many of these bottles are out there! It's a two-hour process to take them from bottle form to activated carbon. That's really quick compared to how most people are making carbons now—it takes a good part of a day."

And he's just starting to work with lignin—the tough stuff that holds up the cell wall of a plant. "This is the stuff the newspaper printers try to take out because it yellows the paper," Lipka says. "It's a waste material. Do you think they would pay me to haul it away so I can convert it to useful carbons to store energy? Maybe."

"People are making carbons out of rice hulls, peach pits, coffee beans, all kinds of crazy stuff. There are a lot of carbons out there that are used for other applications that can be tweaked to store charge. I'm just looking for the cheapest and most efficient."

For Lipka, it's a world filled with energy-storage potential—he just needs to figure out how to cheaply tap it. More power to him. ■

CAER's Illayathambi "Victor" Kunadian (right), a postdoc who earned his Ph.D. in mechanical engineering from UK in 2008, demonstrates how to trim the material for a capacitor to Ifedi Anyaegbunam, a senior from Lafayette High School. Nearly a decade ago, CAER helped start a pre-engineering program at the Lexington high school as the educational outreach component of a National Science Foundation grant. Anyaegbunam is one of two Lafayette students working with Steve Lipka's electrochemistry team this year.

Every Breath You Take

UK's Jay Zwischenberger
Refining Artificial Lung

By Jeff Worley

We take our next breath for granted. We don't think about it. We just go about our business, or pleasure, and there it is, regular as the tick of a clock.

But imagine that this gift of breath has been damaged beyond repair. Your only hope is a lung transplant. Your doctor tells you that currently in the United States around 3,500 patients a year wait for a lung transplant, but only 1,000 of them have the operation due to the lack of donors. Unfortunately, the majority of those in need of a transplant will not live longer than one or two years without it. In 2004, more than 500 people waiting for a transplant died. You think about your odds as you wait, listening to time rush by like an icy wind.

The University of Kentucky's Jay Zwischenberger (his friends and colleagues call him "Zwisch") is doing something to improve these odds. For the past 20 years, he's been working with a group of researchers from the universities of Michigan, Pittsburgh and Maryland to develop and refine a miniaturized heart-lung machine that has evolved into an artificial lung apparatus. This device isn't implanted in place of a donor lung; it's paracorporeal, or outside of the body, Zwischenberger explains, and small enough to be carried by the patient.

"Our artificial lung is more of a concept than a thing," he says. "It's not a single entity but more like a component

stereo. With this approach, we can keep refining each component as we learn more about how it's functioning by itself and in concert with the other devices as technology improves." He completes the analogy by adding that this approach is clearly superior to an "all-enclosed" system. "You can design an artificial lung like a boom box, where everything's contained in one unit, or you can design it as a component stereo system. The problem is, you can't improve upon a boom box—the way it's put together isn't changeable."



Invented and developed by Jay Zwischenberger (center) and Dongfang Wang, this double-lumen catheter will help patients too sick to be maintained on a ventilator get oxygen into their blood and carbon dioxide out. The FDA approved use of the device last October.

3,500 U.S. patients a year wait for a lung transplant, but only **1,000** of them have the operation due to the lack of donors. In 2004, more than **500** people waiting for a lung transplant died.

Zwischenberger's system begins with a double-lumen catheter, which has two openings—one for infusion and the other for blood removal—combined with a gas-exchanger with a pump that reduces strain on the heart.

Here's how it works. His catheter (patented recently with partner Dongfang Wang) transports blood from the superior and inferior vena cava (veins that carry deoxygenated blood from the upper and lower halves of the body) to a gas exchanger. The gas exchanger removes carbon dioxide and adds oxygen to the blood. The oxygenated blood then returns through the catheter into the right atrium, and the loop begins again.

"Our new double-lumen catheter design directs the venous blood to pass through the artificial lung to allow total gas exchange much more effectively than previous designs," Zwischenberger explains.

This artificial lung has several advantages over a traditional heart-lung machine: It would allow patients to remain ambulatory, no sedation or breathing tube insertion would be needed, and it would dramatically reduce the possibility of infection. "Our artificial lung would also allow the patient to eat and drink normally, and would reduce the incidence of depression, which often afflicts bed-bound patients," Zwischenberger adds.

"In developing all three components of this system, we've been working with some of the top scientists and engineers in the world. We've collaborated with the best pump-maker to continually improve our pump, and we've taken the same approach with our gas-exchange device. We're working with companies in the U.S. and in Europe to develop all three devices," says Zwischenberger, who tends to speak rapidly. He's a man who is eager to tell you the good news.

"There's work to be done," he admits, "but we're

well on our way to building an effective bridge to lung transplant."

In this work, Zwischenberger is using sheep as his animal model. "Their physiology, genetics and size are almost identical to that of a human, and their immunology is very close to ours, too," he says. "Also, this animal is very easy to work with, especially since all of us on my research team have experience with farm animals."

Because the wait for a donor lung may be several years, a major focus of Zwischenberger's project is to keep the sheep alive and healthy much longer than would be possible with a traditional heart-lung machine. "A heart-lung machine is designed to keep a patient going for hours or a few days, possibly for weeks. But not for months," he explains, his voice dropping with the implications of this sad fact. "That's our goal—to buy time for patients while they are waiting for a lung donor."

A Few Decades of Groundwork

Zwischenberger comes to this current research interest from 30 years of work as, first, a cardiothoracic surgeon at the University of Michigan (1977-1986) and then a professor of surgery, medicine and radiology at the University of Texas Medical Branch in Galveston (1986-2007).

"My earliest interest," he says, rolling back the years, "was in taking care of babies who were dying. In the late '70s and early '80s, they died frequently from meconium aspiration and from respiratory distress syndrome. The problem is, the more premature they are, the less they're capable of tolerating either of these conditions. Back then, infants with these syndromes had a 90 percent chance of dying."

Working with a team headed by Robert Bartlett, an international leader in the development of cardiopulmonary

mechanical support systems, Zwischenberger helped develop a technique to treat these endangered babies. This approach, called Extracorporeal Membrane Oxygenation (ECMO), used a heart-lung machine to infuse blood oxygen from outside the body. This way, the blood is given oxygen just as it would be if the lungs or heart were normal.

"We saw a huge and wonderful turnaround then—90 percent of those endangered babies lived," he says, adding that now the use of ECMO is commonplace. He then used this technique for children with heart failure and found they could be effectively treated as well.

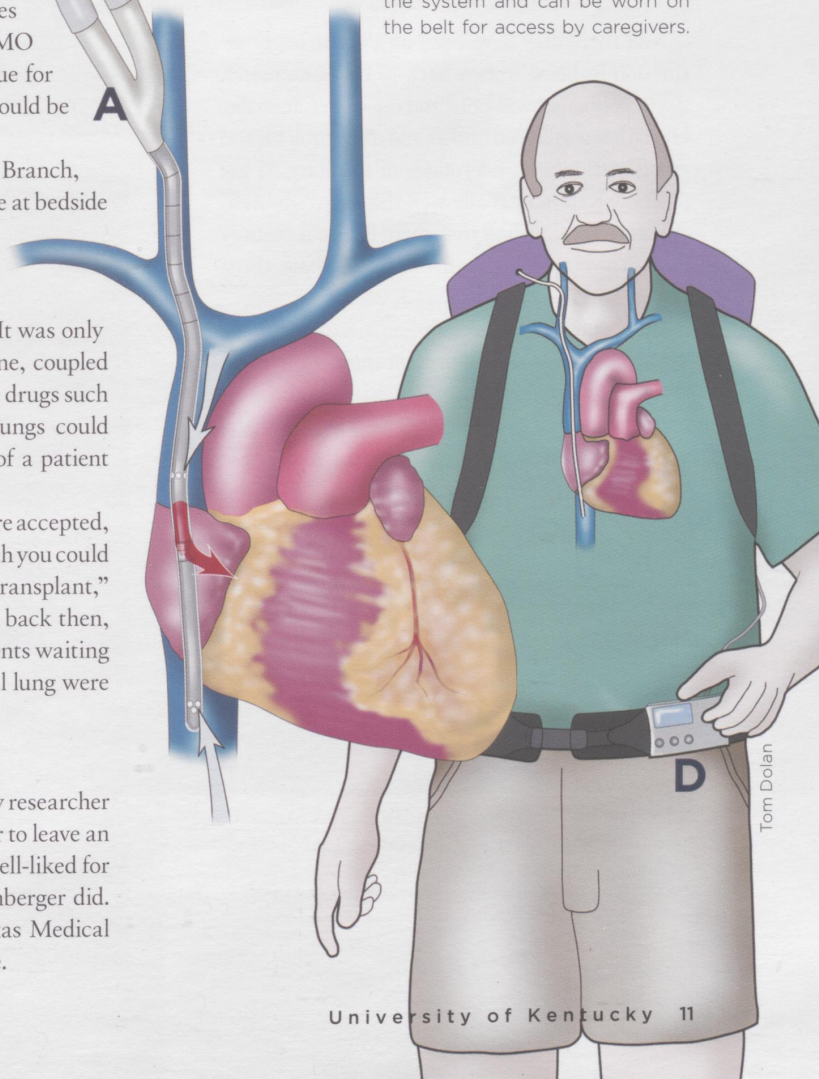
Later, at the University of Texas Medical Branch, Zwischenberger used the heart-lung machine at bedside to aid people for one to three weeks who were suffering from respiratory failure. He also became more and more active in the relatively new field of lung transplantation. It was only after the invention of the heart-lung machine, coupled with the development of immunosuppressive drugs such as cyclosporine, that organs such as the lungs could be transplanted with a reasonable chance of a patient recovering.

"As lung transplants became more and more accepted, it became crucial to have a technique by which you could hold a patient over until he could receive a transplant," says Zwischenberger. "For a period of time back then, we were losing 20 to 30 percent of our patients waiting for transplant." So the seeds of his artificial lung were sown.

Back Home in Kentucky

It's atypical for a faculty member, a university researcher and physician in the later stages of his career to leave an institution where he's been successful and well-liked for 20 years, but that's exactly what Zwischenberger did. After two decades at the University of Texas Medical Branch, he packed up his life and came here.

Zwischenberger's artificial lung design begins with a double-lumen catheter (a), which is inserted into the body through the jugular, the large vein in the neck. The catheter is threaded through the right atrium of the heart, where it sucks de-oxygenated blood out of the upper (superior vena cava) and lower (inferior vena cava) body. The blood is sent through a gas-exchanger (b), which can be tucked into a backpack. This machine removes carbon dioxide and adds oxygen back to the blood before returning it directly to the heart. A tiny membrane inside the catheter separates the oxygenated blood from the de-oxygenated blood. This system is run by a state-of-the-art pump (c). A console device (d) controls the system and can be worn on the belt for access by caregivers.



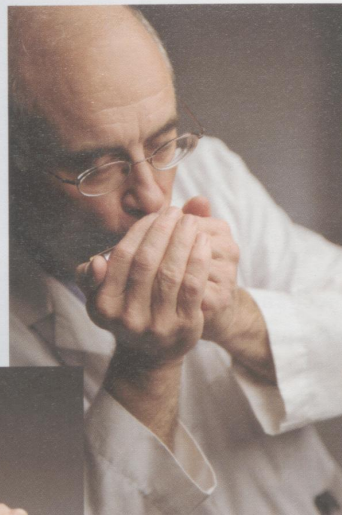
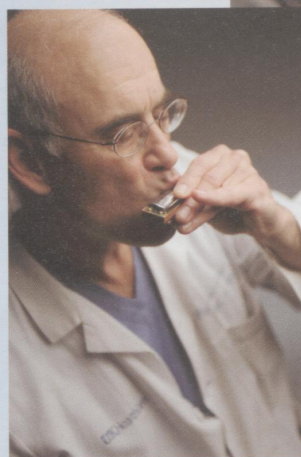
Tom Dolan

"I was impressed with the direction Jay Perman and Mike Karpf have taken the med center here in the past few years," he says. "The disciplines here are integrated, and there's a lot of cross-fertilization among departments." Perman is dean of the College of Medicine; Karpf is the executive vice president for health affairs. "I also liked that they encourage department chairs to be active. I knew I'd be able to do clinical practice as well as research. It was a perfect fit.

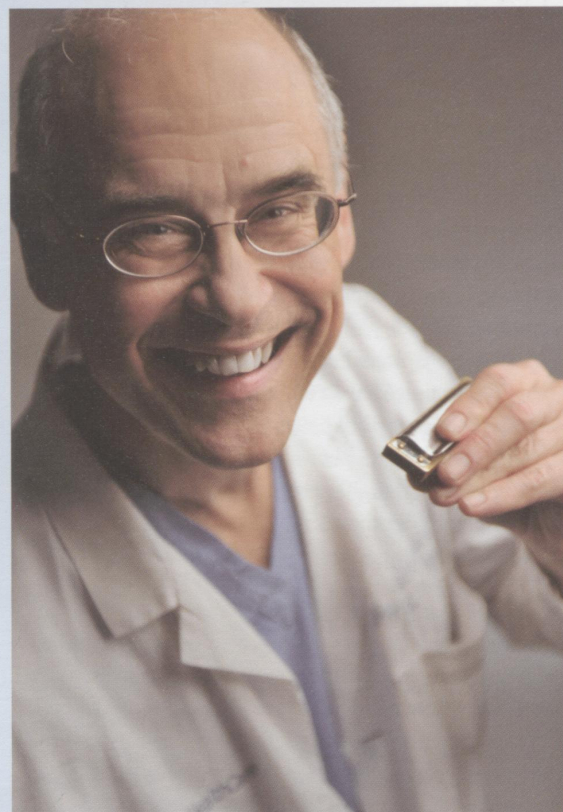
"Also," he says smiling, "there may have been the magnet effect. My medical degree is from UK, you know."

And there may have been an even stronger attraction in being drawn back to his alma mater. Zwischenberger was born and raised in Louisville. His father was a seed broker and often took his son along with him on his rounds of the state. "I got to know Kentucky really well this way," Zwischenberger says, adding that there is also a "family factor" at play in his return to UK. "I have three siblings, and all four of us are UK alums."

Then, putting long-established UK connections aside, he returns to the present moment and his research. "Looking down the road, I think UK is particularly well positioned to be a leader in the field of artificial lung development. I've brought an entire research team with me from Texas, and our College of Medicine has recently renovated the large-animal lab. It's a terrific facility. And our group has buddied up in this work with basic scientists here who were already standouts in related disciplines." ■



"There are peer-reviewed studies that focus on the healthful effects of music," says Jay Zwischenberger. "I started playing harmonica seven years ago. It's a wonderfully versatile instrument, and I love playing for my staff and patients."



Riffing on Better Health

Lung power. This is the focus of Jay Zwischenberger's work—and play. He just may be the only surgeon in the United States who is never without his harmonica.

"I have it with me at all times," he says from his medical center office. He slides a harmonica from his lab-coat pocket and blows a few notes. "Would you like to hear western? Blues?"

Zwischenberger is known for playing a tune while he walks through the suite of operating rooms or for patients, who have said that they find "Dr. Z's" music a source of comfort and reassurance.

Physicians have long believed in the healing power of music, and numerous recent studies have shown music's power to soothe and help mend the troubled mind and body. A recent study in the *Journal of Advanced Nursing* concluded that people diagnosed with depression who listened to music for at least one hour each day reported a reduction of symptoms by up to 25 percent. When a harpist plays in a neonatal ward in Savannah, Georgia, where premature babies are cared for, the heart-rate monitors on the babies calm down, according to a recent article in the *Savannah Morning News*.

There's a growing movement in some U.S. hospitals to introduce music in health care in an innovative way, and UK is in the vanguard of this new focus, with a program to integrate the arts at the new Albert B. Chandler Hospital. The \$450 million facility, scheduled for completion in 2011, will feature a specially designed auditorium adjacent to the building's main lobby. That may not seem unusual.

Teaching hospitals do, after all, need space to conduct classes, as well as to host faculty and guest lectures. But this auditorium will be different. The 300-seat theater will be equipped with state-of-the-art acoustics and audio/visual technology so that musical, dramatic and other live performances can be seen by UK staff, visitors and the public. And for patients who want to come but can't make it? The performances will be piped directly into their rooms.

"We want to use music and art to make the hospital a more friendly, less daunting place," says Zwischenberger.

"I'm not aware of another facility that can actually stage live concerts and televise them as the performances are going on," says Michael Karpf, the university's executive vice president for health affairs. "This initiative raises health care to a new level."

"We have a major grant from the Lucille Little Foundation that will set up a concert series," Zwischenberger says, "which will include everything from classical music to bluegrass." The UK School of Music will supply much of the talent from more than 40 ensembles, covering music genres that range from classical to jazz.

"Studies continue to show that music not only has a soothing effect but may also lower blood pressure and heart rate, and stimulate a person's immune system to ameliorate some diseases," Zwischenberger adds. "To me, music is both a universal language to allow immediate connection between patients and colleagues, and a discipline, like research, that opens new pathways in your mind."



UK is in the vanguard of a new focus to integrate the arts with health care. The new \$450 million Albert B. Chandler Hospital will feature a 300-seat theater equipped with state-of-the-art acoustics and audio/visual technology so that musical, dramatic and other live performances can be seen by UK staff, visitors and the public.

2008-2009

University Research Professors

Craig Rush: Paying Close Attention to ADHD

Inattentiveness, inability to work, procrastination, and feeling distant from others. These are the symptoms of attention-deficit hyperactivity disorder (ADHD), a condition that affects an estimated eight million adults in the United States. ADHD usually persists throughout a person's lifetime, impacting his job, and family and social relationships.

Fortunately, a drug is available that works and works well to counter the effects of ADHD—Ritalin. It's a mild stimulant that increases alertness, but, as with any medication, it has side effects. Craig Rush is testing an alternative drug that shows some promise of fewer side effects.



"One of the problems with Ritalin is that because it's a stimulant, it increases a person's urge to smoke," says Rush, a UK professor of behavioral science who has been studying the pharmacology of drug abuse for 17 years. "Young adults who are dealt the ADHD card are already at increased risk to smoke—over twice as many people affected with ADHD smoke compared to adults without the condition—so this Ritalin side effect may be one that patients down the road can't afford to risk."

Rush, who speaks in a steady baritone, is leading a clinical trial of a new drug, Strattera, a non-stimulant that may work equally well as Ritalin but won't increase the craving to smoke. Since Strattera has been on the market for a relatively short time, not a lot is known about it. Strattera appears to provide 24-hour coverage that might carry over into the next day, and the drug's antidepressant properties may provide effective treatment for those with depressive and anxious symptoms in addition to ADHD.

Rush's ground-breaking study includes two groups of smokers, those who have ADHD and those who don't. Here's how it works. A volunteer comes to Rush's "lab"—actually a suite of rooms off campus—and is given Strattera in pill form. After an hour, the time it generally takes for the drug to take effect, the subject, unaware of the study's hypotheses, is taken to a small ventilated room and given no instructions. "The room has a recliner, a TV with a DVD player and a stack of DVDs, and a wide variety of magazines," Rush explains.

A pack of the subject's preferred brand of cigarettes is also there, as well as a basket of snacks. "We're not only monitoring smoking, but also their eating behavior, because Strattera might also be an appetite suppressor. We're curious about the differences, if any, between calorie intake of the two groups."

So far in this study, the 12 subjects in the control group have been filmed, and their smoking and eating habits assessed. Several of the ADHD volunteers have also completed the study.

"What we know so far," Rush says, "is that Strattera didn't increase smoking among the control group. Its effect was negligible. Of course, we hope this drug will have a similar non-effect on the ADHD group."

Rush was "happily surprised" to win a Research Professorship this year and says that some of the money has already gone to hire a graduate student, Megan Poole, to work on this project. "This study will funnel into her master's thesis, and I'm glad we are able to give Megan this support," he says. ■ JW

John Anthony: Going Green with Carbon Electronics

You know the chorus from that old Irving Berlin song: "Anything you can do I can do better. I can do anything better than you." It pretty much sums up UK chemist John Anthony's challenge to silicon-based technology. His goal is to take anything you can make with silicon (think ceramics) and make it cheaper and greener with carbon (plastics).

Liquid-crystal displays (LCDs are the hot HDTV sets) and radio-frequency identification (RFIDs are tiny white tags that already appear on some products and will one day replace barcodes) are made from pricey and brittle silicon. But Anthony is tweaking carbon-based molecules to do these things and more.

Anthony, an effusive teacher who says his goal is to get his students to understand how the minutia fits into the big-picture solution, is constantly looking for the next big thing. For several years Anthony has been working on flexible solar cells (tiny semiconductors that convert solar light into electricity) to replace expensive silicon solar panels. (See *Odyssey*, Winter 2007, "Green Energy.") In a new project, scientists at Cornell University are making solar cells using his tailor-made molecules and buckyballs.

Buckyballs (a.k.a. fullerenes) are soccer-ball shaped molecules composed entirely of carbon atoms. "The intrinsic electrical properties of these things make them great for solar cells," Anthony says, citing good electrical conductivity and heat resistance. A lot of companies are working on buckyball-based products, but buckyballs aren't green, and Anthony explains that's due to the fact it takes a lot of electricity to produce them. "You have to shoot enough juice through graphite to turn it into a gas. And then only a fraction of what you get is buckyballs.

"That's why we're jumping in, with our friends at Cornell, to replace buckyballs with cheaper materials and get the work commercialized. A year or two down the road—when you'll need to drop the price of the technology to really get consumers to buy in—we'll be ready with a greener and cheaper replacement." Anthony's green solution is to chemically transform petroleum byproducts and coal waste into molecules suitable for solar cells. "We can convert 5 percent of the sun's energy into electricity with our best buckyball mix, and we're working on matching that with these green molecules." He adds that his Research Professorship funds are supporting a grad student who has

just submitted her first publication on new materials for low-cost plastic solar cells.

Anthony's tackling another hot technology—flat-panel displays. Think a beautiful flat-screen TV, but one that rolls up and fits in your briefcase. "The display market is the one area where consumers are still spending money. If we can make something ultra-thin, flexible and low-cost, people will want that technology." In 2005, Anthony founded Outrider Technologies, a company that makes semiconducting materials for a range of applications, especially displays.

He shows a picture of a black and white, 10.5-inch display made by Sony. Incredibly, this flexible, see-through display—no thicker than a dozen sheets of paper—is made by inkjet printing. Anthony's molecules are dissolved in a solution and the inkjet printer sprays them onto a flexible material. "My molecules form the control elements, the on-off switch, and this



display is 76 dpi—that's a better resolution than my laptop monitor," Anthony says.

But Anthony's not stopping there. His next green display idea—replace the inkjet printer (the solutions required give off volatile organic compounds, chemical gases that contribute to indoor air pollution) with simple crayons. "Yeah, people laugh at my pie-in-the-sky semiconducting crayon. You'd just take the molecule itself and scribble. No waste, no solvent, totally green." ■ AG

Jim Griffioen: Inventing the Next Internet

It's a good thing the future of the Internet doesn't depend on Jim Griffioen's gaming skills. Griffioen, director of the UK Laboratory for Advanced Networking, laughs as he admits, "I'm one of the worst game players you've ever met. Challenge me to any computer game, and I will lose." But the next generation of the Internet—and all the things we use it for, from interactive gaming to scientific computing—will certainly be shaped by Griffioen's back-to-basics research funded by the National Science Foundation.

His "Postmodern Internetwork Architecture" project asks the question, "If we took a clean-slate approach to the Internet, what would we do differently?" Griffioen's work with fellow UK computer scientist Ken Calvert and cohorts at the universities of Maryland and Kansas seeks to answer that question.

Griffioen, whose career began on an Apple computer in math class his senior year of high school, says, "In looking at how the Internet has evolved over the past two decades—what it was designed to do and what we're making it do now—we've learned a lot of lessons."

When the Internet was first conceived, the goal was

simply to get computers on different networks to share information. The backbone of the Internet is made up of routers. Acting as baggage handlers, routers process chunks of information, called packets, and forward them to their destination.

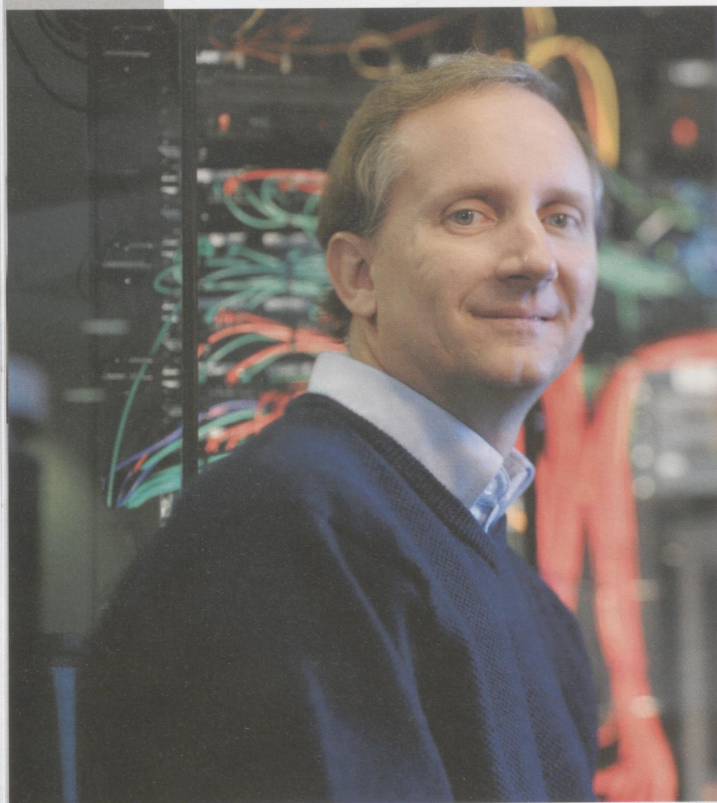
Griffioen explains that routers weren't designed to handle issues like security, privacy and authentication ("How do I verify that I'm talking to who I think I'm talking to?"). These issues have been addressed by stopgap mechanisms and "overlay" networks, which "are not particularly well-designed and won't be necessary if we rework the fundamental architecture of the Internet," he says.

Part of his plan is to provide each packet with "motivation." He gives an analogy: "It's like the packet has cash. So when it gets to the router, it says, 'Here, I've got money. I'll pay for my ticket across to the next stop.'" The packet would get this "cash" along with a "stamp of approval" before entering the network.

The biggest change Griffioen proposes is taking the "rules" away from the routers. Right now routers have a built-in set of rules, or policies, that they apply to every packet they encounter. If a hacker sends an email with a malicious attachment, the router forwards that packet like all the others. Internet service providers (companies that sell access to the Internet) have created mechanisms like filtering and firewalls to try to combat these nasty interlopers. But "as anyone with email has experienced," Griffioen says, with a knowing look in his ice blue eyes, "sometimes these filters make mistakes." Legitimate emails can end up in your spam folder or good attachments can be blocked.

"We want to build an infrastructure that decides the policies outside the network and then tells the routers which packets to forward, so the problem where routers forward a packet just because it got into the network largely goes away," he says.

By separating the policies from the network, Griffioen adds, senders will have more control over where their packets go. "Right now each router acts independently to choose the shortest path between point A and point B. If a mechanism outside the network could identify multiple paths between A and B, and send packets over three or four paths at once, the Internet could much more quickly and efficiently deliver high-definition video. Right now we only get a single path, and I want to change that." ■ AG



The UK Board of Trustees first awarded University Research Professorships in 1977. The goal of these \$35,000, one-year professorships is to enhance scholarly research and awareness of UK's research mission by recognizing outstanding faculty.

Jonathan Glixon: The Music of the Sisters

Practice, practice, practice. Any of us who have played an instrument have had this exhortation drilled into us. UK musicologist Jonathan Glixon says that in his early teens he decided he wanted to play the violin professionally, but encountered a major stumbling block: he hated to practice. "Then in high school I met a musicologist and realized I could do music but never have to practice again! That was a major turning point in my life," says Glixon, a professor in the UK School of Music whose office in the small Wesleys House on Rose Street is a storehouse of books on sacred music, Venetian opera, and Renaissance and Baroque music.

Glixon's interest in the history of music took him to Brandeis University, Princeton University—where he earned a Ph.D. in musicology in 1979—then to UK four years later. In his quarter century here, he has received fellowships from the National Endowment for the Humanities, and grants from the American Council of Learned Societies and the American Philosophical Society. His articles have appeared in many American, Italian and British publications.

Honoring God and the City: Music at the Venetian Confraternities, 1260-1807, Glixon's first book, was published by Oxford University Press in 2003. "Confraternities are religious and charitable organizations of laymen, who also used music in their ceremonies and other observances," Glixon explains. His history chronicles the music practices of confraternities over a 500-year period.

Glixon's second book happened, he says, by accident. "In a dusty old Venetian archive—most of what I do involves reading old books—I discovered documents having to do with 17th-century opera that were in the collection of one of these confraternities." Glixon couldn't wait to tell his wife, Beth, who also teaches in the UK School of Music and usually goes with him on his research trips to Italy. "Beth's field is Venetian opera, and she was thrilled by what I'd come across." This serendipitous discovery led them to do further research in this area and co-author *Inventing the Business of Opera: The Impresario and His World in Mid-Seventeenth-Century Venice*, published by Oxford University Press in 2005.

Glixon is currently working on a book on the role of music in the lives of Venetian nuns in the 16th to 18th centuries. "I'm interested in the music they performed in their religious services and also the music that was performed for them. Books they owned. Organs they built."

This is the "formal" music that helped shape the nuns' lives, but Glixon is also studying other music that floated their way. "Sometimes the nuns heard music they weren't supposed to hear," he explains, "from outside the walls of the nunnery. Love songs, perhaps, or maybe," he adds, with a slight smile, "some guys floating down the canal singing dirty songs."

Glixon's work on this book will be accelerated by the Research Professorship, he says, because now he can "buy time" from teaching and work on the book full-time.



"One of the aspects of this work that I've always found interesting is how women lived when equality with men wasn't possible, when they weren't granted a voice in how society was run. Even though these nuns were the most suppressed group of women, locked away from public activity, they found ways of expressing themselves either directly or indirectly, of making a life for themselves." ■ JW

Nikos Pappas: Not Just Fiddling Around

By Jeff Worley

Ask Nikos Pappas his favorite kind of music, and you're likely to get the look of a man who's just been asked the cube root of 3,837. Or, if he decided to answer the question, he might say something like, "classical, sacred, orchestral fiddle music."

Pappas, a doctoral candidate at UK in musicology, admits that when it comes to music his interests range far and wide. And he blames his family for this inclusive musical orientation.

"Yes, my family—going back to my great-great grandparents—is clearly to blame for this. Everybody in my family has been singing and playing music since the 1850s. My great-great grandparents met at a singing school at that time, and both branches of the family tree, in Indiana and New Mexico, have been musicians and singers since then."

A striking man with a robust physique and strong voice, Pappas sports a bushy, red beard and sometimes talks with his hands for accompaniment, almost as if they're busy on the keys or strings of an instrument.

"The Indiana side of the family were classical musicians, and my great-great aunt was the first woman to graduate with a degree in piano from Indiana University—class of 1906. On the New Mexico side, everybody was a traditional musician, singing and playing music passed down orally through the years. So clearly it's in my blood to be torn between the two. There's a longtime running joke on both sides," Pappas says, his face easing into a grin: "You have to *audition* to get into the family."

Working with Ron Pen, a professor in the School of Music at UK, Pappas is putting the finishing touches on his dissertation, titled "Patterns in the Sacred Music Culture of the American South and West (1760-1860)."

"Nikos, a voracious scholar, is doing extremely important work in this field," says Pen, who also serves as director of the John Jacob Niles Center at UK. "Because he is not limited to thinking *about* music but, rather, thinking *through* music, Nikos's dissertation presents a new vision of American cultural diffusion."

In this study, Pappas is reexamining sacred music, based upon the primary sources. "Many scholars who have worked to characterize sacred music at this time looked only at what was in print. I'm looking at both printed

and manuscript sources," he explains, "with the goal of rewriting the conceptual understanding of sacred music culture as it developed in the South and West."

By "sacred music," Pappas means hymns, anthems (biblical prose set to music), service music (liturgies, for example), vespers, and requiem masses. "Though African-American spirituals and shouts lay outside of the hymn category, strictly speaking, they could be considered because the spiritual, like the hymn, is very repetitious between verses," he explains.

"It's a wide range of material I'm studying."

The traditional body of scholarship following, Pappas says, "a pretty outdated" line of reasoning, has asserted that 19th-century Southern and Western sacred music descended from the intellectual and religious tenets of New England.

"I've found that the Middle Atlantic actually initiated this expression, because of the unique cultural and religious pluralism that existed only in this area. Philadelphia was the primary point of departure for settlers going South and West, and, as a result, it filtered musical and cultural trends to the Southern back country, the Ohio River Valley, the original Southwest (Alabama, Mississippi, Tennessee), and many points in between."

His dissertation project is a huge undertaking. When he's finished in May of this year, Pappas will have prepared a database of approximately 45,000 pieces of sacred music. He's hoping this work will result in two publications: a version of the database and a book from the narrative of the dissertation.

Pappas is not only a music scholar, but also a musician. He started playing classical music on violin and viola at the ripe young age of 3, and this interest evolved over the years to playing the fiddle.

And play the fiddle he does: In just the last three years Pappas has won several prestigious fiddle championships—at the Morehead Oldtime Fiddlers Convention, the Ed Haley fiddle competition, and the Uncle Dave Macon Days traditional fiddle competition. "I don't enter these contests so much to win as to honor the namesakes by playing their music," he says, modestly. "I just love to play these tunes, especially Ed Haley's music." Haley, a blind fiddle player from West Virginia

who lived in Ashland, Kentucky, and played during the first half of the 20th century, was widely regarded as the best fiddle player in the area. Pappas also plays fiddle with the Red State Ramblers, UK's award-winning old-time string band.

So what's the difference between a violin and a fiddle?

"Well, someone told me once that a violin has strings, and a fiddle has *strangs*," Pappas laughs. "But there are clear stylistic differences. Certain fiddle styles use chording and double-stops, or bends and slides. And some players like to improvise on the fiddle." He adds that fiddle music is more "functional" than classical, that fiddlers play tunes to dance to.

Pappas has contributed this knowledge of local traditional music to Kentucky performances and celebrations. Since he's been in Lexington, he has tapped into the community as a Kentucky Humanities Council scholar for the Lexington Philharmonic Orchestra and as an arranger for the Lincoln Bicentennial.

"I was commissioned by the humanities council to prepare a set of pieces, ballroom dances, that were composed in Kentucky in the 1840s, when Lincoln was courting Mary Todd," Pappas says. "For the past year the philharmonic has been performing that set of pieces with period dancers—it's really an exciting and colorful thing to see. And the orchestra has also performed some early 19th-century Kentucky pieces that I reconstructed."

How does Pappas think about these diverse interests? "I like to consider myself a well-rounded person—researching, playing, arranging, preparing editions, and making music available for people to play. Life's too short not to make the most of all of these opportunities."

"Nikos has a wide-ranging and intensely inquisitive intellect," says Pen. "In his time at UK, he has essentially won the triple crown of fellowships: the prestigious Alvin H. Johnson AMS 50 Dissertation Fellowship, the Andrew Mellon Foundation Fellowship, and the American Bibliographic Society Reese Fellowship." ■

To hear Nikos at the recent Ed Haley competition, search "Nikos Pappas" at www.youtube.com.

Project Flowing Around



Working toward a comprehensive grammar of Shughni are (from left to right) Greg Stump, Andrew Hippisley, Amanda Barie, Shoxnazar Mirzoev, Muqbilsho Alamshoev, Jeanmarie Rouhier-Willoughby, and Gulnora Mirzovafoeva.

Grammar School for Scholars

UK linguists work to save an endangered language

By David Wheeler

When a language dies, we lose more than just words. We also lose stories, poems, songs, and history. An entire cultural panorama—a unique way of seeing the world—vanishes.

In the Pamir Mountains of eastern Tajikistan—bordering Afghanistan in Central Asia—speakers of a language called Shughni wonder if their native language and culture have a chance for long-term survival. Young people are slowly, unconsciously, replacing Shughni words with their nearest linguistic equivalents in Russian or Tajik—the predominant languages of commerce, education and the media. Another danger is

under-documentation. Little is known about Shughni, even among language scholars, in part because Shughni is not a written language.

But a new chapter in the story of the Shughni language began last summer. A team of UK faculty, led by linguistics professor Greg Stump, hosted three Shughni-speaking language scholars from Khorog, Tajikistan, for a month-long workshop in the William T. Young Library. This workshop, funded by UK's College of Arts and Sciences, the English Department and the Linguistics Program, laid the groundwork for a long-term international collaboration.

Their goal is to produce a comprehensive grammar of Shughni—the first of its kind. The grammar will not only provide linguists worldwide with the data and analysis for further study of the language, but will also allow speakers of other languages to learn Shughni more easily. Because Shughni is not a written language, the researchers represent it by means of a system of transcription based on the Roman alphabet.

“At present, there is no English-language dictionary or grammar of Shughni,” notes Stump, who came to UK in 1983 after earning a Ph.D. in linguistics at Ohio State University. “Our work will fill that void.” In the longer term, the linguists say, they also hope that through their collaboration they will foster a change in Shughni's status—from “endangered” to “stable.”



The Nuts and Bolts of Shughni

Since the summer workshop, the Shughni project has gained the attention of a documentary filmmaker, the U.S. State Department, and Public Radio International, which featured the project on its program *The World*. In addition to Stump, the UK linguistics team includes professors Andrew Hippisley (like Stump, a member of the English department faculty), Mark Lauersdorf and Jeanmarie Rouhier-Willoughby (Department of Modern and Classical Languages), as well as student researchers Amanda

Barie, Darya Bukhtoyarova, James Mastin, and Dustin Zerrer.

Rouhier-Willoughby was instrumental in the genesis of this project. As the campus coordinator for the State Department's Junior Faculty Development Program, she typically arranges for scholars from parts of the former USSR to come to UK to audit classes in their field and to work with specialists in their discipline. "I was Gulnora Mirzovafoeva's advisor on her first trip here, in 2007," Rouhier-Willoughby explains. "On her application form, it said she was a native speaker of Shughni, so I hooked her up with Greg to work in his grammatical analysis class. The rest, as they say, is history," she says, smiling.

Mirzovafoeva, who teaches English, grammar and discourse analysis at Khorog State University, near the Afghanistan border, returned to UK for this summer's workshop. She was accompanied by two of her colleagues at Khorog

Continued on p. 24

Investigating the Science of Language

If you've ever wondered how a slim chance and a fat chance can be the same, but a wise man and a wise guy are opposites, or how a house can burn up as it burns down, you've entered the realm of the linguist. "Our territory is the phenomenon of language," says Greg Stump, an English professor who directs the linguistics program at UK. "We work to figure out why languages are the way they are, how all languages are alike, and how they differ from one another."

Stump gives an example, and when he talks about linguistics, he gets as excited as a kid with a new bike. "In English you can say, 'He didn't know who hit him.' In that case the 'he' and the 'him' can refer to the same person, or 'he', 'who', and 'him' can refer to three different people—the non-knower, the hitter, and the hittee. Yet if you say, 'He hit him,' 'he' and 'him' can't refer to the same person. Now why is that? Is that a peculiar fact about English grammar, or is that a fact about language everywhere?" It turns out, says Stump, answering his own question, that every language is like English in this syntactic structure and meaning.

"But," Stump continues, "take a statement like 'I wonder who that saw him.' It's obviously not grammatical in English, but in some other languages, sentences of this kind are perfectly fine. These similarities and differences are scientific facts that linguists try to explain."

Stump is a man clearly in love with his chosen area of study and has made an international reputation in his development of a theory of morphology. "Greg is a world figure in the field of morphology, that part of linguistics that deals

with the structure of words," says Greville Corbett, a professor in the Department of Linguistic and International Studies at the University of Surrey in England. "His 2001 book *Inflectional Morphology* is a masterly achievement."

Linguists, like all scientists, are specialists, but what exactly linguists spend their time doing is a mystery to a lot of people, Stump admits. He recalls an encounter with a seatmate on a flight Stump took to a language conference.

"He asked me what I did for a living, and when I said I was a linguist, I got the most dreaded question a linguist can get: 'Oh, how many languages do you speak?' I didn't know what to say, so I said, '27,'" Stump laughs, his bushy eyebrows jumping up like startled caterpillars. "I don't recall if there was any further discussion."

When asked why someone should study linguistics, he says, "Gee, that's an easy one. One reason is, it gives insights into workings of the human mind. We don't often have very direct access to what the mind does, but linguists live in this domain of study." Linguistics is also a basis for studying human history, he points out. "When you compare English with other languages, you find striking similarities that tell us the languages must have descended from a common ancestor."

When Stump came to UK in 1983, there were six faculty members in the linguistics program. Thanks in part to his efforts over the years, there are now 12.

"I'm really pleased about the stellar hires we've been able to make in the past few years," Stump says. "Rusty Barrett, a sociolinguist from the University of Texas at Austin,

Andrew Hippiusley, an expert in Russian morphology from the University of Surrey, and Mingzhen Bao, a perceptual phonetician from the University of Florida. These impressive young scholars fit in well with our already-strong linguistics faculty."—JW



Greg Stump, director of the linguistics program, whose book *Inflectional Morphology* has been called "a masterly achievement"

A comprehensive grammar of Shughni—the first of its kind—will not only provide linguists worldwide with the data and analysis for further study of the language, but will also allow speakers of other languages to learn Shughni more easily.

State—Muqbilsho Alamshoev and Shoxnazar Mirzoev. Besides teaching language and linguistics at Khorog State, both men are affiliated with Tajikistan's Academy of Sciences.

At the workshop's daily two-hour group meetings, the participants discussed a range of issues in the analysis of Shughni grammar, including patterns of pronunciation, word formation and sentence structure; the objective was to identify aspects of Shughni grammar that had never been analyzed systematically. These discussions often took place in three languages. "Our discussions typically became very animated," says Stump, "with analyses and ideas being translated from Shughni to Russian to English and maybe back again. Muqbilsho and Shoxnazar, who are older and speak a more traditional variety of the language, would sometimes disagree strongly with Gulnoro, who speaks the more innovative variety that young people use."

Now, Stump and Hippiisley, sitting in Stump's office—every available surface heaped with papers and books that evince different projects in various states of becoming—take some time to reflect on the immensity of the project. "Just think how exhausting it would be to try to fully characterize English grammar," Stump says. "It would be a long, complex job, and Shughni is no different. The more we worked on it, the more we realized that there's a lot going on in the grammar of this language."

But several important linguistic discoveries have already been made and chronicled, some of which were explicated in a paper on Shughni verb inflection co-authored by Stump and Hippiisley. Stump presented the paper at the University of Surrey in Guildford, England, in September. Verb inflection is the change of form by which some words indicate certain grammatical relationships, in number, case, gender, or tense.

Hippiisley says that Shughni also offers an interesting prepositional system, which can be easily seen in connection with a ubiquitous part of Shughni

life—the mountains. "The prepositions of directions don't just say 'go away from' and 'go out of,' but 'to move up a vertical plane' or 'move down a vertical plane,'" he explains, adding directional cues with his index finger.

"This system based on situational proximity is unlike any we've ever seen before," Stump adds.

In addition to Hippiisley and Stump's collaboration, Rouhier-Willoughby is working with Mirzoev on Shughni's lexical semantics—the study of how and what the words of a language denote.

"The Threat to Shughni Is Real"

When the opportunity arose to work with the UK team, the Shughni scholars were elated. "There's a great amount of knowledge among all of the linguists involved," Alamshoev says through an interpreter.

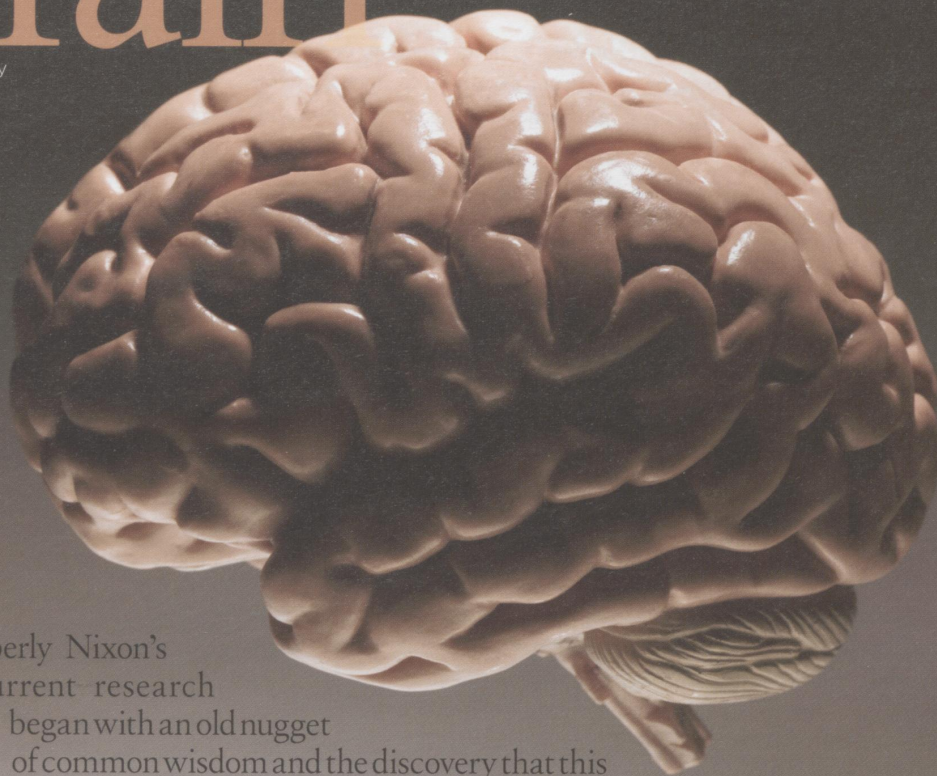
During the workshops, all three Shughni scholars described the urgency of the project. The government of Tajikistan, a former Soviet republic, supports the preservation of Shughni among its 60,000 speakers, but much more work needs to be done. "The situation now is that both Tajik and Russian are influencing Shughni quite dramatically," says Alamshoev in his booming voice. "As a result, the language may disappear and we'll lose part of ourselves."

"The threat to Shughni exists," says Mirzoev pointedly, "and it would be extremely sad if it were lost." ■

Bringing Back the Brain

UK researcher working to trigger the birth of new neurons

By Jeff Worley



Kimberly Nixon's current research began with an old nugget of common wisdom and the discovery that this long-held belief was dead wrong.

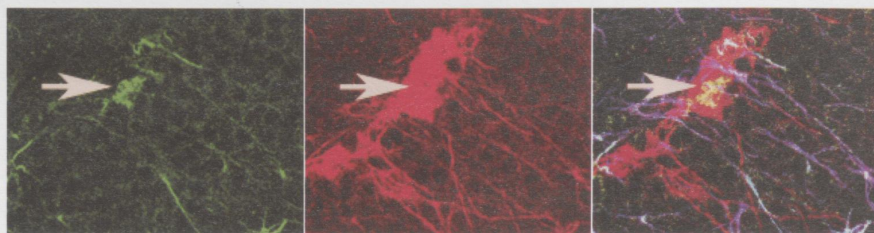
"Once upon a time, scientists thought that when longtime alcoholics destroyed brain cells, they were simply gone forever, even if the drinker jumped on the wagon and stayed there," says Nixon, an assistant professor in the UK Department of Pharmaceutical Sciences. "We've known for some time now that when an alcoholic becomes abstinent, some brain mass recovers. What researchers in the field haven't considered is that new neurons could be born and help in this recovery, which is the focus of our work right now."

Discovering how new neurons aid in this process would be big news indeed. If they can be induced to form in the alcohol-damaged brain, some regions could be repopulated with healthy cells to stave off significant impairment.

In this brain work, Nixon is focusing on two types of cells—glia, the supporting cells of the nervous system, and neural stem cells, which are able to become a range of cells found in the nervous system.

"We're asking some very basic questions about how alcohol affects these different cell types," states Nixon, whose energy and contagious excitement about her work have been stoked by three major federal grants she's won in the past two years. "One of the important discoveries we've made is that alcohol may trigger interactions between microglial cells and neural stem cells, which only recently were

Through a process called immunohistochemistry, which uses colorized labels or markers to see proteins expressed by cells, Nixon and her team work to identify these cells from the brain of a rat who has not been given alcohol for four days. The arrow in these panels points to the same place in each image and shows that multiple markers overlaid one another—a nonspecific stem cell marker called Nestin (green) and a newborn neuron marker called Doublecortin (red). When green and red are expressed in the same place, their colors combine to identify the yellow neural progenitor cell, which is likely in the process of becoming a neuron. This image was taken on one of the new Leica confocal microscopes in UK's Imaging Facility.



found to contribute to brain function. Now we're working to find out exactly how alcohol affects these cells." This project is supported by a five-year, \$1.6 million grant from the National Institute on Alcohol Abuse and Alcoholism.

This is very complex work, because in the regions of the brain that can regenerate—the hippocampus and the subventricular zone—several types of cells besides the glial and stem cells spew out various brain chemicals and growth factors. Trying to catalog and describe the functions of these cells and how these functions interact and lead to neurogenesis, the birth of new neurons, is a daunting task. The hippocampus is primarily involved in learning and memory; the subventricular zone serves as a source for neural stem cells in the front of the brain.

Nixon uses rats as her animal model in this work. Rats were the best choice, she explains, because the animal's brain is remarkably similar to the human brain, and a rat, when intoxicated, behaves very much like we do. "We chose this particular rat model based on previous research that showed clear evidence of brain damage, brain shrinkage, and neurodegeneration that mimics what we see in humans."

In the lab, Nixon and her staff of six—graduate and undergraduate students, a postdoc, and a technician—give rats alcohol through a tube three times a day at eight-hour intervals for four days, a dosage that results in a blood alcohol level of around 0.30—nearly four times the legal driving limit for humans. "This level of intoxication mimics the binge drinking of the true alcoholic," Nixon says. "Bingeing alcoholics are much more likely than other drinkers to have cognitive problems, learning and memory deficits, and physical brain damage."

The rat's behavior is monitored and noted at different dosage levels. "We give an injection of an agent called Bromo-deoxy-Uridine (BrdU), which is commonly used to detect proliferating cells in living tissues, before, during or after alcohol exposure so we can label dividing cells," Nixon explains. "Any cell that is in its DNA synthesis phase of cell division will incorporate BrdU into the DNA."

After a week in abstinence, the rat is sacrificed. Why a week?

"We chose the one-week time point based on evidence from other types of brain damage. The brain, it turns out, has a fairly consistent response to damage—regardless of how that damage occurred. You get a burst in microglia

dividing one to two days after neurons start dying, then you have this reactive increase in neural stem cell proliferation at six to seven days after cell death. This proliferation results in increased newborn neurons four weeks later."

Through a method called immunohistochemistry, Nixon attaches a color to proteins or "markers of interest" in the brain tissue sections that her team studies, and these colors announce themselves brightly through a microscope. "The cool thing about BrdU is that it permanently labels these dividing cells, so we can clearly see how many cells—and which ones—survive or remain," says Nixon, underlining "which ones" with her voice.

The research team is also characterizing these newborn cells to see what various stem cells have "grown up to become," as she puts it. To observe and describe the cells, Nixon uses Leica confocal microscopes, which allow her to optically "section" a fluorescent sample (such as a cell that has been stained with contrasting fluorescent dyes) with excellent resolution. Nixon explains that by collecting a series of such images through the depth of a sample, she is able to assemble a highly accurate three-dimensional reconstruction of the entire sample.

"These state-of-the-art microscopes are indispensable in this work," she adds, adamantly. "You can't lead or be a top-20 university without this kind of facility and equipment."

At this point in the project, Nixon and her lab have shown that the proliferation of neural stem cells leads to a twofold increase in the number of new neurons generated. "The next big questions we're trying to answer are why and how this reactive neurogenesis occurs," says Nixon, who came to UK in 2005 from the University of North Carolina. "We hypothesize that it is related to the fact that after two days in abstinence these microglia in the brain can release growth factors that promote neurogenesis. But we'll see. We're getting closer to the answers every day."

Excessive alcohol consumption is the third leading preventable cause of death in the United States, according to the Centers for Disease Control and Prevention (CDC), and is associated with a number of health problems, including liver cirrhosis, various cancers, unintentional injuries, and violence. In a report five years ago, the CDC estimated the number of deaths attributable to alcohol at nearly 76,000 and that alcoholics lose approximately 30 years of life on average. These sad stats emphasize the importance of adopting effective strategies to reduce excessive drinking.

"One strategy, I guess you could call it, is to let alcoholics know that if they stop drinking and remain abstinent, there's a good chance—50-50 at least—that their brain will fully recover, that their ability to think and reason will come back," says Nixon.

From the beginning of her alcohol-related work here, Nixon has been "buoyed up," she says, by the wealth of expertise of so many UK colleagues who are proven leaders in the field. "The major thing that brought me here was the other alcohol researchers. I had always worked at major alcohol research centers across the country, so I knew several of the researchers here: Susan Barron and Mark Prendergast in psychology, John Littleton at the Kentucky Tobacco Research and Development Center, and Jim Pauly and Audra Stinchcomb in pharmaceutical sciences. This was an impressive research core, and there was just no doubt that this was a great fit for me." Nixon was also drawn by the presence of UK's Spinal Cord and Brain Injury Research Center, where she is a faculty associate.

"Dr. Nixon is an example of the gifted scientists we have been successful in recruiting to Kentucky who are making a difference with their work on a national and international level," says Kenneth Roberts, dean of the College of Pharmacy. "We take great pride in her exceptional achievements in garnering NIH funding to advance research in treating alcohol abuse and alcoholism." ■

The recipient of three major federal grants in the past two years, Kimberly Nixon says, "If alcoholics stop drinking and remain abstinent, there's a good chance—50-50 at least—that their brain will fully recover, that their ability to think and reason will come back."





Fighting PCBs with Nutrition and Nanoparticles

Toxic Turnaround

By Alicia P. Gregory

The good news: PCBs (polychlorinated biphenyls)—a class of hazardous chemicals used in coatings for electronics, sealants, adhesives, paint, and flame retardants—were banned in the 1970s. The bad news: these toxic compounds continue to linger in groundwater and soil as part of our food chain.

Where do PCBs lurk? “Across Kentucky,” says Bernhard Hennig, an expert in human nutrition who has been in the UK College of Agriculture’s Department of Animal and Food Sciences since 1984. He says Kentucky has more than 200 hazardous waste sites on the active list for control,



cleanup or monitoring under the federal Superfund program. One such site is the Paducah Gaseous Diffusion Plant—the only operating uranium-enrichment plant in the United States and one of the top 14 sites on the EPA's national priority list.

Hennig says some fish caught in Kentucky rivers have high levels of PCBs. "PCBs are often stored in fat and pass from food to humans. These chemicals get into your digestive system, where they are absorbed in combination with other lipids (fat-soluble molecules), carried in the blood and deposited into tissue.

"PCBs can cause inflammation and oxidative stress—factors in disease progression. Our work has shown that PCBs can damage the cardiovascular system in this way. So it's no surprise that PCBs are a problem in Kentucky, a state whose rates of chronic diseases like cardiovascular disease, cancer, diabetes, and hypertension are well above national averages," Hennig says.

Is there anything people who live near toxic sites can do to fend off the PCBs in their bodies and blood?

Eat better. That's Hennig's novel hypothesis. His research focuses on the effects of nutrition on PCB-caused dysfunction of endothelial cells (the cells that line the blood vessels). Hennig's work and that of engineer Dibakar Bhattacharyya, to use nanotechnology and free radicals to destroy these toxins before they can reach the human body, are two of five critical projects in UK's \$10 million grant from the National Institutes of Health Superfund Basic Research Program.

Hennig, who is the director of the UK Superfund Basic Research Program, says 2008 marked the second consecutive five-year Superfund grant for UK. He calls the 600-page proposal a huge challenge and admits,

"it's probably one of the reasons why I have so little hair left.

"Superfund grants are very competitive. Last year the NIH got 18 submissions and funded only two—us and Dartmouth. UK joined 13 other prestigious national universities with ongoing Superfund programs."

What set UK apart? A unique interdisciplinary biomedical focus on PCBs and nutrition (with projects headed up by Hennig, Michal Toborek and Lisa Cassis) coupled with non-medical projects tackling chemical detection and cleanup (Sylvia Daunert and Bhattacharyya). "We've brought together more than 50 scientists and students representing more than 15 academic departments in the colleges of Agriculture, Arts and Sciences, Engineering, Medicine, and Pharmacy. UK is one of the few universities with a strong College of Agriculture and a College of Medicine." And Hennig says he knows how beneficial such academic proximity can be.

"I received my Ph.D. at Iowa State University, a land-grant institution and," he says, only half joking, "it's a good place because there's not much else to do but study. I moved on to Iowa City to do postdoc work at the medical school. But those two schools are 125 miles apart. At UK, because everything is together, we can all sit down and brainstorm. Progress comes when you talk to people who don't do the same things you do. The NIH likes interdisciplinary research."

UK's Superfund program focuses not only on research, but also on student training and outreach. Leonidas Bachas in chemistry heads up the certificate in environmental studies program, while Lisa Gaetke in the College of Agriculture provides nutritional education programs for people in communities directly affected by PCBs.

Good nutrition can fend off PCB damage

So how did Hennig, a native of Germany who retains a marked accent, end up in the United States studying nutrition? "I intended to go to medical school to become an ophthalmologist and take over the family practice in Germany," he says, but in the process of applying to medical school, Hennig happened to visit a distant relative in San Francisco.



Bernhard Hennig, who directs the UK Superfund Basic Research Program, says we can fight the toxic effects of PCBs by eating better. His novel work is one of three biomedical projects focusing on PCBs and nutrition, and is coupled with non-medical projects tackling toxin detection and cleanup.

"It was 1972, right after the hippie movement, and it was a beautiful time. I took some biochemistry courses at San Francisco State University and met my wife, then got accepted back in Germany. So I had to make a decision." He pauses, and with a smile, says, "It's not money that turns the world around, it's love, right?"

He also stayed with biochemistry, and he became interested in nutrition, and specifically obesity. Hennig, who is now a faculty associate of the UK Graduate Center for Toxicology and the Graduate Center for Nutritional Sciences, says, "Even in those days Americans' waistlines were growing faster than those of people's in other countries."

And today in Kentucky, high-fat diets and sedentary lifestyles are making people more susceptible to chronic diseases. "When you add in exposure to environmental pollutants, Kentuckians are even less able to fight off the toxic assault."

Hennig has proven this hypothesis by studying the endothelial cells of animals on specific diets—healthy and otherwise. He adds that because he and the other Superfund biomedical researchers—Toborek and Cassis—share animals and tissues, they can see how PCB damage is related in various parts of the body. Toborek, in the College of Medicine, is looking at the ways in which PCBs can stimulate the growth of cancerous tumors and the spread of cancer. Cassis, in the Graduate Center for Nutritional Sciences, is studying the ways PCBs promote obesity and related cardiovascular diseases like atherosclerosis.

“Blood vessel constriction and vessel relaxation are regulated by endothelial cells,” Hennig explains. “Think of a garden hose. Water passing through the hose is like blood in a vessel. These cells make up the very inner layer. They communicate with components in the bloodstream and the underlying tissue.”

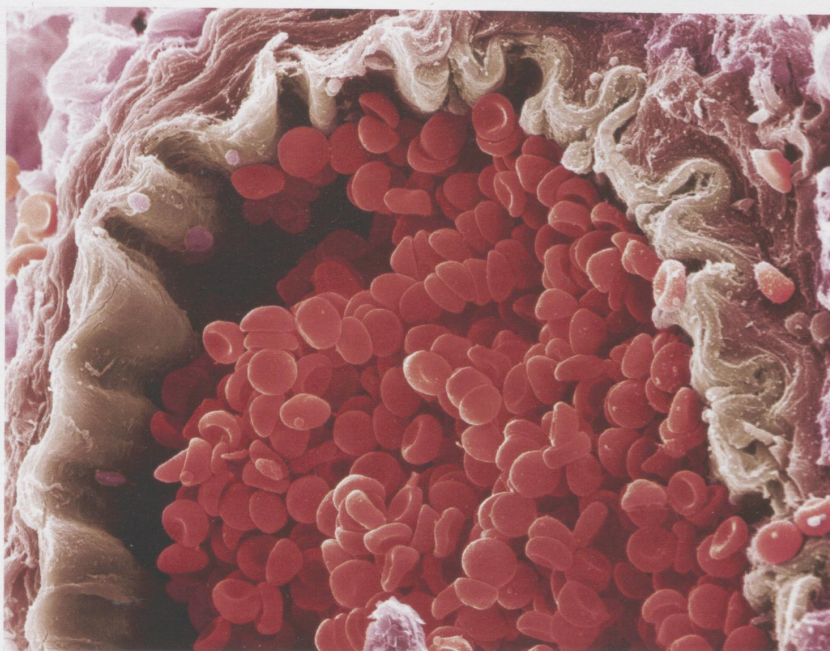
If a toxin floats by and activates the endothelial cells, they may signal for help in the form of cytokines. But these helpers bring inflammation (a protective attempt to remove the toxin as well as initiate the healing process), which can trigger the formation of plaque. Plaque buildup on the wall of a blood vessel can lead to a heart attack.

“We found that certain dietary fats can amplify the toxic response of endothelial cells to PCBs. But not all fats are equally bad,” Hennig says, suggesting that the widely touted omega-3 family may protect blood vessels from damage. Omega-3 is found in fish, flaxseed and walnuts.

Hennig also found that antioxidants like vitamin E can actually reduce the toxic impact of PCBs on endothelial cells, and he’s investigating the protective potential of “bioactive compounds” in fruits and vegetables. “Have you heard of the French Paradox? The French and the Finnish people eat about the same kind of fat, but the French are much more resistant to cardiovascular disease. And scientists think it’s because they drink wine.”

Hennig, who will spend four months this spring teaching a nutritional biochemistry course at the Universidad de Antioquia in Columbia, thanks to a prestigious Fulbright grant, says, “This work is fascinating because in

This colorized scanning electron micrograph (SEM) of red blood cells in an artery shows a layer of endothelial cells (beige) surrounded by muscle (pink).



Steve Gschmeissner / Photo Researchers Inc.

trying to understand how PCBs are involved in chronic diseases, we’re discovering easy ways to modify our risk by manipulating diet.”

Ideally, PCBs won’t get a chance to reach the human body. That’s the job of a new breed of membranes to detoxify PCBs in soil and groundwater.

Catching PCBs with nanoparticles

Longtime UK chemical engineer and Indian native Dibakar Bhattacharyya, or DB as he’s known to colleagues and friends, says he can trace the origin of his current work on PCBs to an after-hours meeting in 1996.

It all started with a phone call from Subhas Sikdar, the associate director for science at the EPA’s National Risk Management Research Lab. “Dr. Sikar said, ‘DB, I’ve got a challenge for you. Create a material that can capture toxic metals—like lead or mercury—in water at a pound-to-pound ratio.’” He meant 1 pound of metal captured to 1 pound of material used, DB explains, adding that the very best material at the time could pick up

only .01 pound of metal per pound of material. "If you can find a solution, I'll make sure you get grant funding. But the deadline's coming up, so you've got to hurry." I said, "Give me one day to think."

So DB went to his computer and, with help from chemistry colleague Leonidas Bachas, hammered out an idea. "I'll take a membrane with big pores—holes about 200 nanometers wide—and inside those holes put a long chain of amino acids (the building blocks of

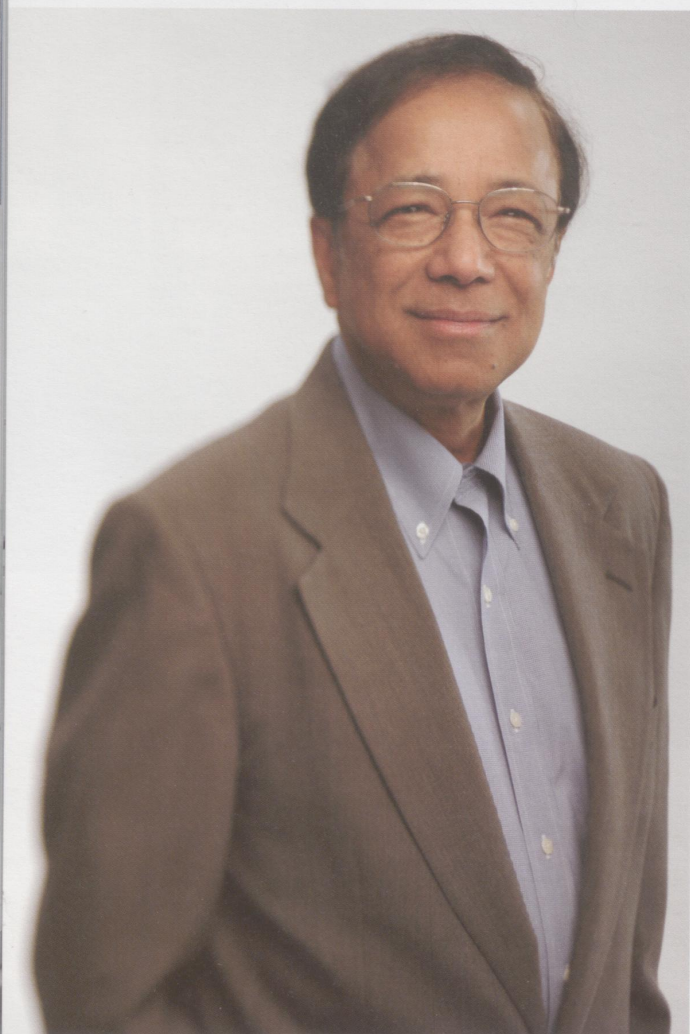
proteins) called polypeptides. Polypeptides have multiple sites that can capture metal," DB says, his voice rising as he remembers the excitement he felt at the time. He offers an analogy: "Think of an Indian goddess with many arms. Imagine that on each of her fingers I could put a different coating to catch a different chemical. I could pick up five chemicals at the same time with each hand. This is the principle." With 100 polypeptide "fingers" to catch metal, DB calculated that he could get a pound-to-pound ratio. So he called Sikdar.

"That's a brilliant idea," Sikdar told me, "but you're going to need to prove you can do it. Do some experiments and write a proposal." I needed money to get the proof. So Leonidas and I went to see David Watt, a fellow chemist and then vice chancellor for research. He didn't have time to talk and said, "Come back to my office at 8:30 tonight." I did and pitched him my idea. "I need \$10,000 fast to prove I can do this. I can promise with 99 percent certainty that you'll get your money back a hundred-fold."

Watt thought DB's idea, which innovatively melded biology, chemistry and materials, was a winner, and the next day got DB that 10 grand. "With the aid of a postdoc, I ran some experiments and voilà—got the EPA cooperative agreement grant." Four patents, numerous publications, and many industrial applications later, that \$10,000 investment yielded half-a-million dollars in funding from the EPA, Department of Defense and industry.

And to combat PCBs, that polypeptide concept morphed into the new world of nanotechnology. "But before we get into that, you need to understand that membranes are beautiful things in themselves," says DB, who is also a faculty associate of the UK Center of Membrane Sciences. He adds that membranes are the bread and butter of chemical engineering. "I teach a

Membrane expert Dibakar Bhattacharyya, who came to UK in 1969, is using nanotechnology and free radicals to destroy PCBs in soil and groundwater. His nanoparticles break down PCBs by removing chlorine; then free radicals destroy the toxins.





This miniature membrane roll is an example of the material to which DB's team attaches nanoparticles to filter out the toxic chlorine in PCBs.

graduate-level course in which I challenge my students to make a synthetic membrane that can last 90 years. Everything we know about membranes we've learned from the human body. Your kidney separates out proteins, getting toxins out of the body, day after day for 90 years. Why can't we make membranes to do that?"

He says membranes are mostly used for filtering out things—for example in water desalination, water goes through but the salt doesn't. But DB wants to catch and hold toxins instead of letting them pass through. That's where the nanoparticles come in.

"If you have nanoparticles, you have thousands of surfaces," like the fingers in his previous analogy. He takes a membrane with big holes (about 400 nanometers across), attaches polypeptide-like materials and creates iron nanoparticles coated with a tiny amount of palladium (a rare metal similar to platinum), then passes contaminated water through it to successfully break down PCBs. "The nanoparticles don't destroy PCBs, but they do make them less toxic by removing the chlorine." To completely eliminate the toxins, DB

takes a second step: "We mix citric acid (an ingredient of vitamin C), iron sulfate tablets and hydrogen peroxide to make free radicals. And the free radicals kill PCBs."

Go figure. Free radicals—molecules with unpaired electrons that can wreak havoc in the human body and are likely culpable in Parkinson's and Alzheimer's—are the solution to PCB destruction. "We've already used this free-radical technology at an industrial site in Kansas, so we've seen it work."

He notes there are several ways to deploy these membranes: grind them up and inject them underground, use them above ground in a pump and filtering system, or line a groundwater holding pond with the membrane. "And soon we'll apply our free radicals and nanotechnology to the Paducah Gaseous Diffusion Plant groundwater decontamination project."

DB says no one has ever used free radicals like this before, and it comes as no surprise when he adds, "My philosophy is to thrive on the frontiers of science. You can't follow the crowd. A bold approach equals science that makes a difference." ■



DB created this membrane containing immobilized nanoparticles (on a scale of 20 to 30 nanometers) of iron and palladium.

By Jeff Worley

More than four years ago, in the heart of tobacco country, a smoke-free law went into effect for all buildings open to the public, including bars and restaurants, in Lexington, Kentucky. What effects has this law had on community health in Lexington and in other cities that have adopted these laws? On smoking rates? On local businesses' bottom line?

Ellen Hahn, a professor in the UK College of Nursing, wanted to know the answers to these questions, so in 2005 launched six research projects to see if this law was working and, if so, how well. Hahn, the driving force behind the smoke-free initiative, assembled a team of faculty, staff and students from the UK colleges of Nursing, Public Health and Business who spent three years researching the early effects of this law.

When Hahn talks about the smoke-free initiative, and contingent concerns such as smoking rates in the state, she is direct and adamant. She clearly gets fired-up by the smoke-free issue.

"One of the several important results of the smoke-free law is that in the 32 months after Lexington's

ordinance, there was a 22 percent decline in emergency department visits for asthma," she says. In Hahn's project that determined this decline, the first study of its kind, several members of her team gathered data on emergency department visits for asthma in all Lexington hospitals before and after the smoke-free law. Hahn reasons that the decline may have been greater for adults than children (24 percent compared to 18 percent) because many adults are in workplace settings, restaurants and bars affected by this law, while children are more likely exposed to secondhand smoke at home, where the law doesn't apply.

Smoke-Free Laws Decrease Smoking Rates

Hahn was also interested in any general decline in smoking rates in Fayette County. The Behavioral Risk Factor Surveillance System, the world's largest ongoing telephone health survey system, collected responses from 10,413 current or former smokers—7,139 before the law went into effect and 3,274 after it was enacted. The research team examined the number of people in Fayette County who were smokers

before and after the smoke-free law took effect.

The results surprised Hahn. The smoking rate in Fayette County declined nearly 32 percent (from 25.7 percent before the smoke-free law to 17.5 percent after), while smoking rates remained stable in Kentucky counties without smoke-free ordinances. Doug Steinke, an economist and researcher in UK's Department of Pharmacy Practice & Science, then used a well-established extrapolation formula to estimate the healthcare cost savings from this reduction in smoking.

"Lexington's law resulted in 16,500 fewer smokers for an estimated annual healthcare cost savings of \$21 million. That's huge," Hahn says, smiling. "When communities pass smoke-free laws, they don't do it to get people to quit smoking, but this is an unintended benefit."

Why do smokers in smoke-free places decide to kick the habit?

The inconvenience of having to stand outside in the winter keeping company with ice and snow in order to smoke might play a role in this decision, Hahn says, but a more likely reason is that most smokers want to

Smoke-Free Successes

Research Shows New Laws Working Well



"This cigarette ad in the January 1937 issue of *Home Arts*, a needlecraft magazine, was typical of the regular, insidious messaging that the tobacco industry used to promote an ingrained, pro-tobacco cultural norm that continues even today. While there are more advertising restrictions today, the tobacco industry continues to target young people, women and minorities through point-of-purchase, Internet and special-promotions advertising."—Ellen Hahn

quit anyway, and that being forced into a sequestered smoking area becomes one more motivator for smokers who have already been trying to stop.

Breathing Easier in Louisville

In discussing the importance of smoke-free laws, Hahn is adamant about one point. "The *strength* of the law is absolutely critical," she says. Louisville's smoke-free ordinance is a case in point.

A partial smoke-free ordinance, which exempted 400 to 500 bars and businesses, and allowed separately enclosed smoking rooms, was initiated in Louisville in 2005. A year later, Hahn led a study that found the partial ordinance

had little effect on lowering the amount of fine-particle, indoor air pollution—the levels of air toxins were basically the same as before.

A comprehensive smoke-free workplace ordinance was passed by Louisville and took effect in July 2007. This measure required all indoor public places and places of employment to be 100 percent smoke-free, making Louisville one of 14 Kentucky communities to implement this strong type of smoke-free law or regulation.

Did the comprehensive ordinance make a difference in the quality of Louisville's indoor air? UK and University of Louisville researchers, in a project funded in part by The Robert Wood Johnson Foundation and the Americans



Ellen Hahn, a professor in UK's College of Nursing, launched six research projects in 2005 to see if the smoke-free initiative was working and, if so, how well.

for Non-Smokers Rights Foundation, teamed up to sample the air quality in 10 Louisville restaurants, bars and entertainment spots six months after the comprehensive law took effect. Researchers used small, inconspicuous aerosol monitors to sample and record the levels of particles in the air. This sampling showed the level of indoor air pollution fell well below the National Ambient Air Quality Standard for the first time since testing began. According to a report released by the UK College of Nursing and College of Public Health in February 2008, there was a 97 percent decline in air pollution linked to secondhand smoke in Louisville businesses after implementation of the comprehensive law.

Smoke-Free Laws Haven't Hurt Business

From the beginning of her fight to protect people in the workplace, Hahn says the primary argument she's heard against going smoke-free was that businesses would take a big revenue hit. It's a common argument, she says, but findings from as far back as 1993 don't support the contention. New York City's 1995 Smoke-free Air Act had no adverse effects on restaurant employment, and restaurant employment growth was three times higher than in the rest of the state from 1993 to 1997. Gross restaurant sales in Flagstaff, Arizona, increased

16 percent one year after a smoke-free ordinance.

And here at home, two economists—one of them was Donald Mullineaux, a professor in UK's Gatton College of Business and Economics—found that restaurant employment increased after the Lexington law took effect, while the average number of bar workers remained stable.

More recently, area bingo parlors have clouded the smoking issue. Some people imagine bingo parlors shrouded under great clouds of cigarette smoke, equating bingo players with smoking.

"There's this idea out there that everybody who plays bingo smokes, and that's simply not true," Hahn says.

To find out if a smoke-free ordinance would affect revenue of charitable gaming establishments in Kentucky, Hahn headed up a study with Mark Pyles, assistant professor of finance at the College of Charleston's School of Business and Economics in South Carolina. The study analyzed the influence of 13 municipal smoke-free ordinances on charitable gambling, including bingo parlors, and found no significant differences in gross or net revenues before and after the implementation of smoke-free ordinances.

"Our study shows that there is not a sound economic reason to exempt charitable gaming venues from smoke-free laws or regulations," Hahn says. "Gamblers are no more or less likely to smoke than non-gamblers. Most people who want to avoid smoky environments stay away from bingo parlors that allow smoking. A smoke-free environment may actually benefit charitable gaming in the long term."

How about a Smoke-Free State Law?

With all this persuasive data, is Hahn planning to move her smoke-free crusade onto a state platform soon?

"It would seem to follow, wouldn't it, that with the consistent data we've gathered in Kentucky's largest cities and in smaller communities, we'd be knocking at the door of the legislature soon, advocating for a state smoke-free law," says Hahn. "The problem is, too many Kentuckians aren't ready for that yet."

In getting such a state law passed, timing is everything, she adds. "Ohio, Georgia and Tennessee passed statewide smoke-free laws, but because they didn't first enact these laws in enough smaller communities, implementation and enforcement have been difficult." She says it's crucial to "prepare the way" through education about health benefits and local debate about local solutions, especially in heavy tobacco-growing regions. "So we are not in support of doing this right now. But someday, when more Kentuckians are accustomed to smoke-free at the local level, we will be ready for the General Assembly to consider a statewide law. Just think of the immense health benefits. Think about how the \$21 million that's been saved in Lexington would translate to the entire commonwealth."

So Hahn's smoke-free research has moved from the city to rural Kentucky communities. "We're currently building data that will tell us what local communities are thinking and doing as far as smoking policies go. We're talking to elected officials and key citizens to understand the attitudes out there." A five-year NIH grant is supporting this project. ■

Odyssey
Winter 2009

Parting Shots

"Be careful about reading health books. You may die of a misprint."

—Mark Twain

**"Old people
shouldn't eat
health foods.
They need all
the preservatives
they can get."**

—Robert Orben

"After a
year in therapy,
my psychiatrist
said to me,
'Maybe life
isn't for
everyone.'"

—Larry Brown

**"I don't
deserve
this award,
but I have
arthritis
and I don't
deserve
that either."**

—Jack Benny

*"I told the
doctor I
broke my
leg in two
places. He
told me to
quit going
to those
places."*

—Henny Youngman

**"A male
gynecologist
is like an
auto mechanic
who has never
owned a car."**

—Carrie Snow

**"Smoking is
one of the
leading causes
of statistics."**

—Fletcher Knebel

**"Health nuts are going
to feel stupid someday,
lying in hospitals dying
of nothing."**

—Redd Foxx

**"I've just
learned about
his illness.
Let's hope it's
nothing trivial."**

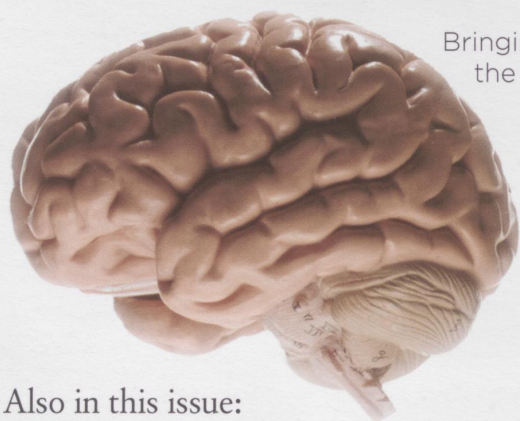
—Irvin Cobb

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