

University of Kentucky Research
Spring 2010

Odyssey

The House
That UK Built

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Gregory Luhan

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The S-KY BLUE house, built by a team of UK students, faculty and staff, gets high marks in the Solar Decathlon, a 10-event competition that was held on the National Mall in Washington, D.C., last fall. Take a tour of the 800-square-foot solar house that combines energy efficiency—which the UK team proved during a three-day waterlog in D.C.—and novel design with accessibility.

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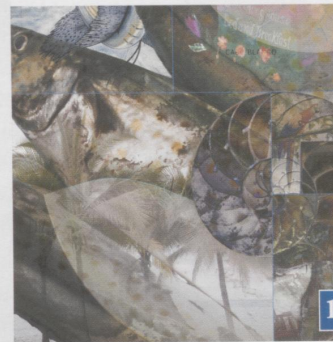
Sanders-Brown Center researcher Gregory Jicha led a pioneering study to determine if telemedicine can benefit patients in rural and remote areas of Kentucky. The answer: A resounding yes.

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Bill Markesbery, tireless director of the UK Sanders-Brown Center on Aging for three decades, was a pioneer in the study of Alzheimer's disease and how to prevent it. His work will live on for generations to come.



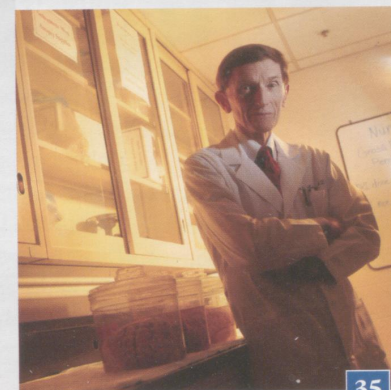
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UK's New Dean of Arts & Sciences

Mark Kornbluh, a scholar whose strong interests in history and technology unite the arts and sciences, is the University of Kentucky's new dean of A&S. Formerly professor and chair of the Department of History at Michigan State University, he also held an appointment there in the Department of Computer Science and Engineering. Kornbluh began his duties at UK last August.

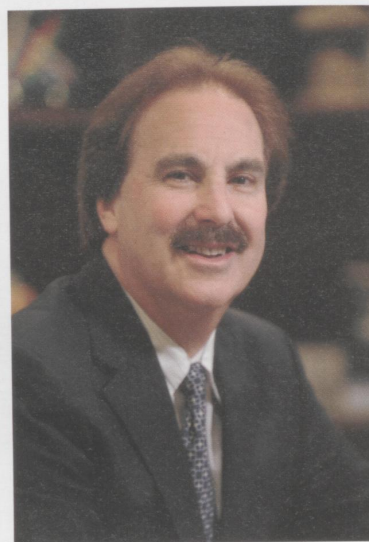
It's not unusual for a scholar's interests to range far and wide, but in Kornbluh's case how did his focus on American voting patterns and participatory democracy (he wrote a book on this in 2000) evolve to embrace scholarship in cyberspace?

"Well, that might seem like a big jump," he says, "but what became clear to me 15 years ago was that communications technology is transforming all aspects of our world, and this includes citizen participation in government. As a scholar I wanted to find out how technology could be used democratically instead of just to sell things."

In 1998 he became the founding director of MATRIX: the Center for the Humane Arts, Letters and Social Sciences at Michigan State. MATRIX is one of the nation's largest humanities technology centers. From 1997 to 2004, Kornbluh was the executive director of "H-Net: Humanities and Social Sciences OnLine," the world's largest online scholarly society. Six years ago, his work took an "unexpected and interesting turn," he says, when he was invited to South Africa to use information technology to chronicle the history of people of color under apartheid.

"Under apartheid, these people didn't officially exist—and nobody of color was allowed to be an archivist, a librarian. History books in South African schools told of the brave white settlers who came to an empty continent." In South Africa Kornbluh worked with a team of U.S. scholars, experts in the use of information technology, to help train a new generation of curators and librarians to capture and preserve the story of South African history and culture.

At UK, Kornbluh is focusing on three areas: expanding the use of information technology in the humanities, internationalizing the campus, and building interdisciplinary connections. "Knowledge is no longer bounded by departments, and a major draw for me to the University of Kentucky was that the administration and faculty here realized that a long time ago," Kornbluh says. "I want to help make UK a centerpiece for humanities and social science technology."



Sanders-Brown Center Appoints New Director

Linda Jo Van Eldik is the new director of the UK Sanders-Brown Center on Aging, succeeding William Markesbery, who led the center from its inception in 1979 [for more on Dr. Markesbery, see article on p. 35]. She came to UK from the Northwestern University Feinberg School of Medicine, where she was a professor in the Department of Cell and Molecular Biology, and associate director of its Cognitive Neurology and Alzheimer's Disease Center.

Last year, Van Eldik won a prestigious Zenith Award from the Alzheimer's Association, one of only four such awards given in 2009. She was recognized for her pioneering work in the area of glia cell biology. Glia cells provide mechanical and physical support and electrical insulation between neurons.



President Obama Picks Two UK Professors for Awards

President Obama presented the Presidential Early Career Award for Scientists and Engineers to two University of Kentucky professors last August: Bruce Hinds (top left), an associate professor of chemical and materials engineering, and David McNear Jr., an assistant professor of plant and soil sciences.

Hinds and McNear were two of 100 researchers nationwide to receive the award, the highest honor bestowed by the federal government on young professionals in the early stages of their research careers. Hinds and McNear received their awards at a ceremony in the historic east wing of the White House last fall. "Obama came in to raucous applause," says Hinds. "It was exciting to see him close up—he conveyed a strong presence and enthusiasm. He spoke to us as a group for a few minutes about how important science and engineering are for our country's future."

Hinds, who is also UK's William Bryan Professor in Chemical and Materials Engineering, conducts research on nanoscale device fabrication.

Science and *Nature* magazines have featured his discovery of a method to make carbon nanotube membranes that permit fluids to flow through at a rate 10,000 times faster than normal materials. This system is being used to pump drugs, using very small voltages, in a programmable skin patch device to treat drug addiction.

McNear is focusing on tall fescue, a popular forage grass, and its symbiotic friend, an endophyte fungus that lives inside the plant. He is studying the effects of the fungus on the chemistry of compounds released into the rhizosphere (the root-soil interface), and how these compounds interact with soil and microbes to influence carbon and nitrogen cycling in fields throughout the Southeast.

"I am thrilled for Bruce Hinds and Dave McNear, but not the least bit surprised," says UK President Lee T. Todd, Jr. "Both of these professors have been conducting leading-edge research from the moment they arrived on campus, and this award validates the fact that their work ranks among the best in the nation and the world."

New Gum Could Replace Toothpaste for Soldiers

In the past, America's fighting men and women have relied on sugary gum included in rations as a way to clean their teeth. Thanks to research conducted at the UK College of Pharmacy, future soldiers, deployed in areas where they don't have the time or the means to brush, could carry chewing gum that will prevent dental decay. This gum is receiving global attention as the product nears testing in an upcoming Phase I clinical trial funded by the U.S. Army Dental Research Detachment.

Developed by pharmacy professor Patrick DeLuca, the gum contains KSL, an antimicrobial, anti-adhesive and abrasive agent that disrupts plaque formation and promotes the dissolution of plaque.

Last fall, Abeer Al-Ghananeem, assistant professor of pharmaceutical sciences, took over the project when DeLuca was elected president of the American Association of Pharmaceutical Scientists. She says, "Once the manufacturing facility is on board, UK will work side by side with manufacturers and help guide them as they come up with a successful formulation."

So far, all research has been done with a chewing machine in Al-Ghananeem's lab, a device which simulates the human mouth chewing—complete with artificial saliva. Al-Ghananeem says she is optimistic that the Phase I trial will be completed within 18 months to two years.

"Troops come home from war with a lot of dental problems that affect their quality of life," Al-Ghananeem points out. "These soldiers don't always have access to water, toothpaste, a toothbrush or the right time or place to take care of their teeth. This research could have a great impact on their health and quality of life, but it also has a global impact, especially in third-world countries. Children born with AIDS in Africa have serious and painful dental problems, and I believe this gum can enhance their quality of life."

—Ann Blackford



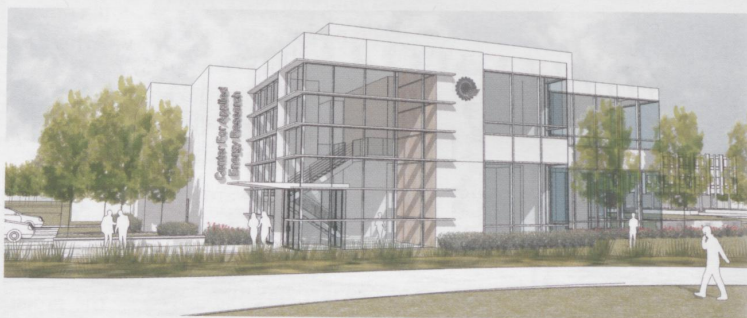
UK Successfully Secures Stimulus Funds

ARRA awards to UK
as of March 31, 2010
\$71,343,460
124 awards

The University of Kentucky has secured \$71.3 million in competitive federal grant funding through the American Recovery and Reinvestment Act of 2009 (ARRA). With grants from nearly every institute and center of the National Institutes of Health, the National Science Foundation, the National Institute of Standards and Technology, and other agencies, UK is using these funds to advance its Top 20 research agenda, to attract excellent faculty, and train the next generation of scholars and scientists.

UK's ARRA grants, which run the gamut from plant-based fuels to autism training for teachers, not only fulfill national goals on renewable energy and job creation, they also tackle our "Kentucky Uglies." This term, coined by UK President Lee T. Todd, Jr., describes the conditions that have held Kentuckians back for generations—poverty, poor health care and illiteracy.

UK's Vice President for Research James W. Tracy says, "The stimulus funds will bolster UK's talented researchers who are making the discoveries that will change the quality of life in Kentucky and our nation."



CAER to Expand with \$11.8 Million NIST Grant

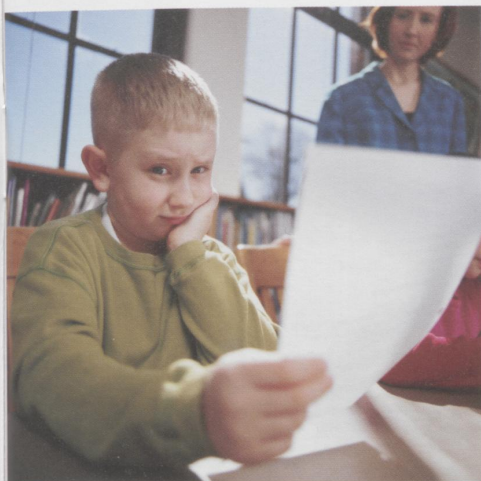
The National Institute of Standards and Technology (NIST) awarded \$11.8 million in ARRA funding to support the expansion of the UK Center for Applied Energy Research (CAER). This grant is being matched with \$3 million from the Commonwealth of Kentucky and \$1 million from UK to complete the \$15.8 million project.

CAER Director Rodney Andrews is the principal investigator on this grant, which will significantly expand the 30-year-old center with a new 36,000-square-foot building dedicated to research in the biomass and biofuels industries, advanced distributed power generation and storage, and technologies for electric vehicles. The facility will include labs for process development, prototype manufacturing and testing, as well as applied research on batteries, capacitors, solar energy materials, and biofuels. The project is expected to be completed in summer 2011.

UK Leads \$6 Million Study of Medicinal Plants

UK is the lead university on a \$6 million ARRA grant from the National Institutes of Health to study the molecular genetics and biochemical potential of medicinal plants. UK's Joe Chappell (plant and soil sciences) will capture the genetic blueprints of 14 plants, such as ginseng and foxglove, known for their medicinal and therapeutic value. By studying the plants' genetic makeup to determine key components that may be important in treating human diseases, this project will speed up drug-development efforts. Experts from Michigan State, MIT, Iowa State, University of Mississippi, Purdue, and Texas A&M will partner on this two-year project.

For more on UK's stimulus funding, visit www.research.uky.edu/arra/pr.



Training Teachers in Autism

The CDC estimates that one in every 150 American children has an autism spectrum disorder. And while the focus on early identification efforts in recent years has been effective in increasing the number of children with autism receiving services in schools, those services are of uneven quality. UK researchers Lisa Ruble and Lee Ann Jung say that all children with autism need access to high-quality, early intervention services, and they

are targeting training for special education teachers.

Ruble, an associate professor in school psychology, and her team received a \$998,940 ARRA grant from the National Institute of Mental Health to examine three types of professional development training and compare their effects on autistic children and their teachers. The UK team will follow 25 children whose teachers receive only basic online autism training, 25 children whose teachers and parents receive consultation from the research team followed by in-classroom teacher coaching, and 25 children whose teachers and parents receive consultation followed by web-based teacher coaching. Ruble's team includes eight UK researchers and students. Teachers from 10 Kentucky counties are participating the first year: Bourbon, Clark, Fayette, Franklin, Madison, Mercer, Powell, Scott, Spencer, and Woodford.

Reducing Opioid Abuse

According to a 2006 drug use survey, 5.2 million Americans had illicitly used a prescription opioid (like morphine, Vicodin or OxyContin) in the past month. National rates of non-prescription opioid use are higher than those for heroin, cocaine or methamphetamine, and are exceeded only by marijuana use.

William W. Stoops, an assistant professor in behavioral science and the UK Center for Drug and Alcohol Research, received a two-year, \$1.17 million ARRA grant from NIH. Stoops is studying the pharmacological effects of tramadol, a synthetic opioid that, based on its novel pharmacology, has less potential for abuse than other opium-derived painkillers. His research could help determine key factors needed to develop other opioid painkillers with reduced abuse potential. The stimulus grant from the National Institute of Drug Abuse will support four current faculty and three staff members. "These funds will allow us to conduct several novel research projects that will answer important questions relating to prescription opioid abuse, a growing problem in Kentucky," Stoops says.

Targeting Lignin for Biofuel

Making fuel from biomass—a.k.a. plant material—is nothing new. Cellulose, a component of the cell wall, is the main target for biofuels production today. While cellulose is good, lignin is better. Lignin, the plant cell component that gives corn stalks their rigidity, is more energy dense than cellulose. Cellulose is easily fermented to alcohol, but lignin is not.

A four-year, \$1.98 million ARRA grant from NSF will fund a project to develop efficient thermochemical (heat and pressure) methods to convert lignin by understanding the chemistry of deconstructing lignin at the molecular level, and engineering plant cells to make it easier and less energy-intensive to process lignin into fuels and chemicals. The lignin project is based at the UK Center for Applied Energy Research (CAER) and headed by CAER Director Rodney Andrews. The research team includes Mark Meier (chemistry), Seth DeBolt (horticulture), and Mark Crocker and Samuel Morton (CAER).





The solar panels on the front of UK's house catch the morning sun during the 2009 Solar Decathlon on the National Mall. The deck provides recreational space for a Kentucky tailgate staple—cornhole.

The House That UK Built

By Alicia P. Gregory

National coverage on the *Today Show*. The highest ranking—ninth place—for a first-time team. These were just two results from UK's impressive showing at the U.S. Department of Energy's Solar Decathlon last fall. The decathlon, held every two years since 2002, challenges teams from 20 universities worldwide to build an 800-square-foot solar-powered house on their home campus, transport the house to the National Mall in Washington, D.C., and compete—rain or shine.

Why a Solar Decathlon? Residential buildings account for 20 percent of U.S. energy usage. DOE Secretary Steven Chu says, "More efficient buildings powered with renewable energy can and must play a major role in meeting the energy challenge. Students represent the next generation of clean-energy pioneers and entrepreneurs, and this event is a great example of what American innovation can accomplish."

The interior features Shaker-inspired built-ins, including a table that slides out of the wall and chairs that hang flat on the wall. The dining table can sit up to eight people. When the table is folded into the wall, the living room gains 96 square feet of space.

UK's S•KY BLUE ("S" for solar, "KY" for Kentucky) team was comprised of students, faculty and staff from six colleges (agriculture, arts and sciences, communications and information studies, design, engineering, and medicine) and 16 centers and departments at UK. The team was led by Donald Colliver, a professor of biosystems and agricultural engineering in the College of Agriculture, and Gregory Luhan, the associate dean for research in the College of Design.

When you ask the students on the S•KY BLUE team what they took away from the experience, you get a wide range of responses: "You look to your left and to your right and see the Washington Monument on one side and Capitol on the other. It's an amazing, incredible experience to build on the National Mall. How many students get to do that?" answers Josh Dudley, who is pursuing his graduate degree in architecture at UK. Both Dudley and his cohort Kellin Vellenoweth started working on the solar house as undergrads and stayed at UK as graduate students to complete this project. Vellenoweth cites practical lessons learned like "you've got to have something to nail to" and "just because it looks like it works on paper, doesn't mean it works in the field."

But the student consensus was, as their mentor Luhan puts it, that the most important result was "proof-of-concept. This project demonstrated to the students that their ideas are buildable, have market appeal, and can compete against the world." And it proved to Kentucky, and the world, that it's possible to construct a Top-10, beautifully designed, energy-efficient, solar-powered house today.

Solar Today

While it was on the National Mall, UK's house had as many as 6,000 visitors a day, with 250,000 total visitors to the competition. Sometimes 100 people at a time were inside the 800-square-foot house. Vellenoweth laughs as he points out: "It was remarkable how many people you could fit in there, without feeling cramped."

Luhan reveals the two most asked questions by visitors touring the S•KY BLUE house: "How much does it cost?" and "Is this something I can do right now?"

The house cost a little less than \$500,000 to construct. The team had a budget of \$750,000 that included money



Jim Tetto

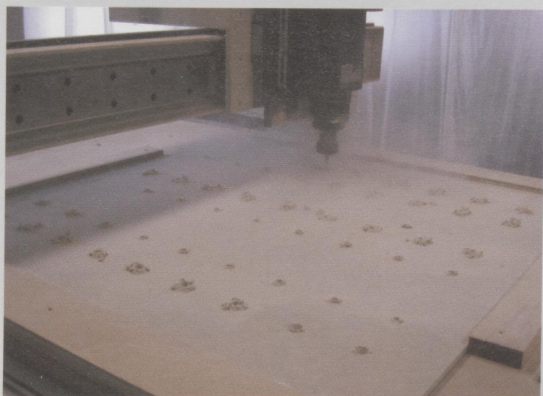


Jim Tetto



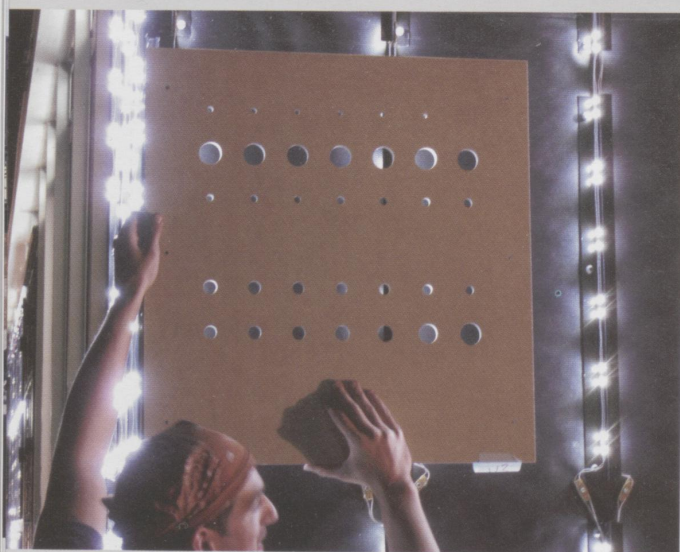
Steve Patton

The "Pick Chairs" designed by Studio Dror in New York and fabricated for the UK team in Milan, Italy, are Shaker inspired. The functional artwork hangs as decoration or can be used as a chair, as an end table, or combined to form a coffee table.



UK's team fabricated more than 100 unique exterior panels from cement fiber board using CNC milling machines in the College of Design.

UK architecture grad student Josh Duddey sets one of the cement boards on the building's exterior. Each panel is placed to form an LED-illuminated façade.



for the team to travel to Washington for a preliminary meeting with Solar Decathlon officials, \$75,000 for photovoltaic (PV) panels (the technology that converts solar radiation to electricity) and wiring, transportation of eight truckloads to and from the Mall, and travel and housing in Washington for almost a month for 30 team members.

"None of this would have been possible without the sponsorship of E.ON, UK and several hundred folks locally and nationally," Luhan asserts. The team received \$250,000 from E.ON-U.S., the Louisville-based subsidiary of the world's largest investor-owned energy services provider and a longtime industrial partner with UK. The team had the help of more than 50 sponsors (through monetary donations, products, materials, and labor). Luhan says 175 students were involved during the two-year project, with a core of 10 design students and five engineering students who spent four months doing the physical construction of the house and the 2,300-square-foot deck.

And, yes, you can build a solar house today. It's pricey mainly because many of the items in the house were custom made and the technology is so new that demand isn't high enough to bring down the cost of manufacturing it. Like anything else, it's about supply and demand. By combining what Luhan calls "leading-edge technologies"—discoveries coming directly from UK laboratories—and third-generation Energy Star appliances from GE (these products, not even on the market yet, use 30 percent less energy than the appliances available now), he says the UK team demonstrated solar power is marketable. "One of our mantras for the project was 'By Kentucky, for the world.' The solar house project has helped put the University of Kentucky on the global map. President Lee Todd is always challenging us to compete on the international level, and we've proven we can compete."

The campus and then the world will get a chance to see the S•KY BLUE house while it's on display in front of the Main Building until September 2010 when it will serve as the Lexington Convention and Visitors Bureau's welcome center at the Alltech FEI World Equestrian Games. Luhan says 1.5 million people are expected to attend the games. "What better way to demonstrate the ingenuity of Kentuckians than to showcase this house when the world comes to Lexington."

Kentucky Tradition & Innovation

Visitors to UK's solar house will see a design that melds leading-edge technology with Kentucky's traditional aesthetics. The house reflects the popular architectural "Kentucky shotgun" design. All of the rooms feed off a single long hallway that runs the length of house. The interior features native Kentucky maple and cherry woodwork, as well as Shaker-style built-in cabinetry and chairs that fold flat and hang on pegs in the main living area when not in use. A large table, which works at a regular dining height or can be raised to counter level for additional kitchen prep space, folds into a panel in the wall. These space-saving features expand the open feeling of the house.

Luhan draws attention to the skylights as well as the low windows placed at the floor in many of the rooms.

“Frank Lloyd Wright had this great idea that you should allow light to come in low and then reflect up deep into the house. One hundred percent of the occupied spaces have natural daylight.”

The exterior, too, bridges aesthetics with technology. It features pixilated photos of Kentucky’s iconic horse farm fences. “We worked with local artists, like UK grad Lee Ann Paynter, to take photographs of Kentucky landscapes. We wrote our own computer scripts to take those photos and turn them into pixels, and then turn pixels into perforations that were punched into the cement fiberboard that wraps around the back of the house.” High-efficiency LEDs (light-emitting diodes) were mounted behind the perforations to illuminate the photos after dark. It’s a uniquely Kentucky twist on night-time lighting for the exterior deck space.

As far as its technology, the S•KY BLUE house is one-of-a-kind. The roof is covered with PV panels that can tilt up and down throughout the year to catch the sun at the best angle. Rainwater collected on the roof is used inside to flush the toilet and wash clothes, and outside to supplement irrigation.

Luhan says their roof and deck water capture design holds 2,018 gallons in the driest month, October, which averages 2.7 inches of rain. “With a single low-flush toilet and Energy Star washing machine, our total water consumption is around 1,700 gallons per month.” The excess water is diverted, purposefully, into the landscape.

Plant water-demand controls, developed and tested by the College of Agriculture’s Richard Warner, detect when plants need moisture, deliver a pulse of water, and then check again to see if more water is needed. “This technology has been shown to reduce water usage by 40 percent while maintaining the quality and amount of vegetable production,” Colliver says.

Inside the house, Luhan explains that the UK team had two goals: generate as much energy and use as little energy as possible. Air conditioning is an energy hog, so the UK team employed an electrochromic system that turns glass from clear to a dark tint (like sunglasses) to reduce the heat gain inside the house. Colliver explains, “During the winter you want sun to shine into the space



Steve Patton

Anne Fugazzi, who earned her bachelor’s degree at UK and is now a grad student in the architecture program, was involved in cost estimating, project manual preparation, and woodwork finishing for the S•KY BLUE house. “I take so much pride in this experience. I put my blood, sweat and tears into this house, and I wouldn’t have had it any other way. I learned to work together with engineers, how to problem solve, use tools and building techniques that I never pictured myself doing. I had the opportunity to understand the design process from a concept to a fully functional, 800-square-foot house that embodies forward thinking and high design. This experience has truly prepared me for my future far more than any other experience I’ve had at UK.”

Ross Graham (left) and Chad Gallas await the placement of the last PV panel. The rooftop array not only generates power, but also shades and cools the roof.

Josh Ayarola



and warm it up, but in the summer you don't want that heat. In our house if you need less sun, all you do is flip a switch that sends a tiny amount of energy to electrically 'charge' the glass to turn it from clear to tinted."

This glass-tinting system is tied to a larger system—the Automated Weather Adaptive Response Energy system (AWARE)—that controls heating, cooling and ventilation. Developed at UK, this system receives zip-code-specific short-term (24- to 72-hour) weather forecasts every three hours, evaluates the various energy storage options available, and selects the best energy plan. The plan that optimizes energy consumption and generation is then implemented for the next three hours.

Jeffrey Kellow, a grad student in biosystems and agricultural engineering, and Josh Shank, an undergrad in electrical engineering, designed the user interface for AWARE. Kellow, who earned his B.S. in mechanical engineering from UK, explains: "The homeowner can

adjust the system and view a display of home energy usage from a touch screen in the living room. I wrote the control code for the home in Visual Basic, which integrated the heating, cooling and ventilation systems, and allowed for control based on the weather forecasts."

Colliver says, "On a single panel, the homeowner can see every circuit and item consuming energy. Nobody else at the decathlon had anything close to that. In fact, the AWARE system is what drew the attention of the editors of NBC's *Today Show*." The national morning show featured UK, as well as Team Germany, Team Boston and Rice University. To see Kellow talk about the system on the *Today Show*, visit: www.uky.edu/solarhouse/media.html.

Above and Beyond a Contest

The decathlon gets its name from the 10 specific areas of competition: architecture, engineering, market viability, lighting design, communications, comfort, appliances, hot

water, home entertainment, and net metering. UK placed in the Top 10 in three of the contests: 5th in net metering, 7th in appliances, and 8th in home entertainment.

Arguably, net metering is the most important competition, the one that is central to the goal of a solar house—producing as much or more energy than you consume. (You might have heard of the notion of “net zero.” This means you produce exactly the same amount of energy as you use.) Each house was equipped with a utility meter that measured how much net energy the house produced and consumed over the course of the competition. Teams scored points for producing as much or more energy than they consumed. Ultimately, the goal is that a solar house would draw electricity from the utility grid only when the sun wasn’t producing enough power and, optimally, send any “extra” energy to the grid for public use.

Luhan says he expected UK to do well in net metering. “With the third-most photovoltaic panels in the competition—behind Team Germany and Team Spain—we should have been able to generate a ton of energy, and we did. The key was using as little energy as possible.” But Mother Nature wasn’t a team player. “The last three days of the competition it rained,” Colliver says somberly. “It rained long and hard. We had two inches in three days. It was cloudy.”

In response to the three-day waterlog, some of the other teams—including Team Germany which won first place at the Solar Decathlon—chose to not compete in all of the contests. Luhan says, “Even Team Germany, who produced more energy than anyone else, decided to close the doors to tours, not compete in all of the events, and have meals catered in instead of cooking them at the house.” It was their prerogative to sacrifice the points from the “smaller” contests to hedge their bet of winning the net metering contest (which Team Germany did). But Colliver says UK took a different path. “We chose to operate the house as intended—to continue giving tours, to wash clothes, to cook meals, to light the house, to have other teams over to watch TV. And we still scored fifth in net metering.”

“Could we have gained more points by shutting everything down? Probably,” Luhan says with a smile. “But



Josh Ayoroa

As the sun begins to set, Chad Gallas (left), Drew Roberts, and Josh Duddey affix the underside of one of the 12 photovoltaic panels.

we proved beyond a shadow of a doubt the validity of our design. From my personal standpoint, I don’t think we would have been able to show the validity, the proof-of-concept, if we had competed in that way.”

“We achieved our goals,” Colliver says. “My personal goal was to write a proposal that would get us accepted into the competition, to get into the Top 20. We had some very stiff competition from some of the biggest schools in America, not to mention Puerto Rico, Canada and Europe. The decathlon didn’t release the number of proposals, but I know that the team that came in first in 2002 and 2005, and third in 2007 submitted a proposal and was not selected to participate in 2009.” Colliver draws

an analogy, with particular meaning for Kentuckians: "Making it into this competition is for engineers and architects what the Sweet 16 is to NCAA basketball teams. It's huge!

"My second goal was to score well in the net metering contest. We scored fifth. We achieved net zero. The numerical results are great, but they weren't the only things we gained."

Soon after the S•KY BLUE team returned from the decathlon, they presented their design in Chicago at the Illinois Institute of Technology, and at USG Corp, a company that makes drywall for commercial and residential buildings. Luhan says, "One of the major folks at USG is Warren Buffett. He's trying to design a house that operates on a dollar a day. Six years ago USG tried to market a very similar solar concept, but couldn't find a foothold for it. When our students presented their product, that they built in four months, USG was pretty excited from a potential donor standpoint for future competitions."

Colliver emphasizes the impact on the students: "All of the great things this team achieved pale in comparison to those 'Ah-ha!' moments when a student said, 'It finally gelled.'"

"This is my 30th year teaching, and I've had more teachable moments in this project than in the 29 years prior, combined. You can describe things in equations and work through homework problems, but at one o'clock in the morning when the student finds out he has to put in a bigger pipe because the pump he installed isn't going to supply sufficient water flow, that's a real-world educational opportunity. You go back to the basic principles they learned in class—what are the key parameters and how did you solve it on the computer? Let's talk about how those parameters impact the problem so you can solve it in the field."

"Our students had a tremendous number of 'Ah-ha!' moments. The learning that took place during this project—that's the lasting value of Solar Decathlon." ■

Making Solar Accessible

"The quarter-inch-thick Solar Decathlon rule book required a wheelchair ramp to make the house ADA compliant so that the public could tour it," Donald Colliver explains. "But our team went above and beyond by making our entire house accessible. (The 1990 Americans with Disabilities Act requires all public spaces to be equipped to accommodate people with disabilities.) "A small house has its own unique design challenges, and then to make it large enough so that you can make all the turns in a wheelchair adds another layer of complexity," says Colliver. "But it was rewarding. In looking at potential markets for the solar house, we identified the 'aging in place' community—people who want to stay in their home as they grow older."

Luhan adds: "We designed a house that would succeed on the National Mall and have an immediate impact upon its return. Our design sets into play many of the philosophies of the original 'green' generation, the people that started the sustainability and recycling movements who are now in their 60s. We wanted to create a product that was desirable for both the 20-something and the 60-something. We took a trans-generational approach, with built-in adaptability and durable materials. Rather than having to do demolition to renovate your home as you age, the house adapts to you."

Pneumatic controls raise the dining table to the height of the kitchen counter. The kitchen counter raises and lowers, and so does the bathroom vanity. "Instead of a small toilet room separated from the shower, we have a 6-foot by 8-foot bathroom. The outlets and control panels are at a comfortable height for everyone." Luhan adds that by adding a module, the one-bedroom, one-bath house can easily become a three-bedroom, two-bath house without sacrificing energy performance or efficiency.

"This accessibility and adaptability was something we came up with as a team that we valued. And the design we created by following the ADA rules made our space just 'feel' better. We designed the house to have a lifetime outside the competition," adds architecture grad student Kellin Vellenoweth.

Josh Ayoroa, an architecture grad student with a background in tool and die manufacturing, says, "We didn't work around the clock—18- to 20-hour days for four months—to build something that would be useful for only a month. We will continue to learn from the house." The S•KY BLUE house will be a "living laboratory," where UK students and researchers will be able to study the efficiency of new technology and refine adaptive systems like AWARE (see p. 10). Ayoroa says, "I've learned that if I choose to pursue green design, I'll probably be able to spend the rest of my life looking at this design challenge, finding new solutions and making innovations." ■

Building Terrifically Tiny Things

By Kami Rice and Alicia P. Gregory

In J. Todd Hastings' world, "small" means really small, as in 100 nanometers or 1,000 times smaller than a human hair. Hastings, who is in his seventh year in UK's Department of Electrical and Computer Engineering, works in nanotechnology and, in the simplest of terms, finds new ways to build tiny things. He's clearly excited about his latest innovation, a nanoscale "printer," and for good reason. It might just significantly reduce the time and expense of making nano-products.

Hastings prefaces his explanation of potentially intimidating nano-things by saying that "because nanoscale research blurs the lines between science and technology—asking scientific questions with an eye toward practical application—it crosses academic boundaries." And Hastings feels right at home with research that crosses disciplines. With a B.S. in physics from Centre College in Danville, Kentucky, and an M.S. from Purdue and Ph.D. from MIT in electrical engineering, Hastings says he was lured back to his hometown of Lexington by the opportunity to join UK's Center for Nanoscale Science and Engineering. The center serves as a nexus for nano-researchers from anatomy and neurobiology, chemical and materials engineering, chemistry, electrical and computer engineering, mechanical engineering, pharmacy, and physics.

Adjusting his oval, wire-rimmed glasses, Hastings smiles as he explains that the applications of nanotechnology run the gamut from traditional electronics (such as integrated circuits for computing, communications, and data storage), biochemical sensors that detect pathogenic bacteria

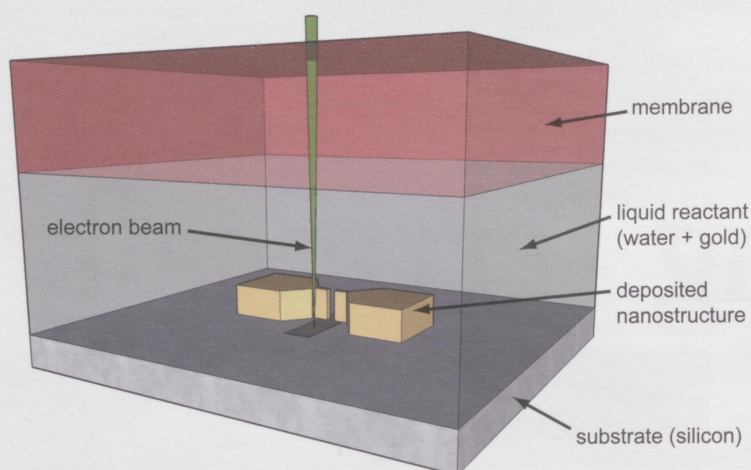


J. Todd Hastings, electrical and computer engineering, developed and is now testing a "printer" that can rapidly try out new nanoscale designs without the lag time of a week or a month it usually takes to build a prototype.

in water or during food processing, to devices that detect cancer biomarker proteins.

He says one of the greatest challenges in nanotechnology is that there's no standard "machine shop" for creating nanoscale devices. "Whatever your ultimate application, actually building the device is often the limiting step," he asserts. "Prototyping—creating an original, full-scale, working model of a new device—is often the hardest part." So Hastings asked: "Can we make it easier and faster to build new devices?"

With preliminary funding from the Kentucky Science



This diagram shows Hastings' "printing" process: an electron beam passes through a membrane, into the water and dissolved gold or platinum, and "writes" the nanoscale pattern on the silicon.

and Engineering Foundation, and a two-year, \$300,000 Young Faculty Award from the Defense Advanced Research Projects Agency (DARPA), Hastings answered that question with a resounding "Yes." He developed and is now testing a "printer" that can rapidly try out new nanoscale designs without the lag time of a week or a month it usually takes to build a prototype.

In the hallway outside his lab, he points to a diagram of his printing process. "We have an electron beam with which we write, the way you or I would write with a pen. We have a silicon wafer—like you'd use to make a computer chip—that we write on, and," he holds up a dime-sized stainless steel capsule, "this holds water containing dissolved gold or platinum. Our process is novel because we write underwater, and the water contains the metal inks we need to create our prototype.

"People have used electron beams to write patterns for electronics for years, but we're the first to do it underwater." He says one advantage of this wet approach is purity. "In our initial experiments with platinum we observed about 90 percent purity." He says that with older techniques, using gas instead of liquid ink, you might get 30 percent platinum and 70 percent other, undesirable materials. He adds that the purer the material on the nanoscale, the better performance you can obtain from the device. The DARPA grant is funding his efforts to determine the range of materials that can be used as ink and how to achieve the highest purity with them.

The importance of writing in these inks is that at the nanoscale the properties of these materials change. For example, Hastings explains, certain metal nanostructures strongly absorb and scatter distinct colors of light. When a pathogenic bacterium or a cancer biomarker protein binds to such a nanostructure, its color changes—giving off a vivid red or green cue that the bacterium or protein is present.

In the basement lab where the exotic-sounding electron beam "pen" resides, Hastings chuckles at the irony that the smaller the thing they are trying to make, the bigger the machine required to make it. "This is a shared piece of equipment—other scientists here use it," Hastings says, acknowledging that a system with a million dollar price tag has to be utilized by as many scientists as possible.

This system includes a monitor, which provides an enlarged view of what the electron beam is told to "write." A six-foot enclosed cabinet with computer components is wired to the guts of the operation—the electron beam. Located inside a chest-high, cylindrical device, the electron beam passes into a big, steel vacuum chamber. The capsule, containing water and the dissolved ink, and the silicon wafer are loaded into the vacuum chamber. "The electron beam comes into the capsule through this greenish window, through the liquid, and prints the pattern on the wafer.

"Our goal is to accelerate the pace of prototyping and decrease the expense. The equipment we use is expensive, but the materials that go into the prototype are the same things you'd use to coat a piece of jewelry with platinum or gold. It's nothing more sophisticated than that, whereas some of the previous attempts along these lines have used really uncommon, incredibly expensive, hazardous chemicals. We're working with much less toxic, much less expensive, readily available starting materials."

Hastings says the DARPA-funded project is particularly exciting because "you always have more ideas than you have time and resources to try out. I hope this project will let us, and hopefully many other scientists and engineers, try out our ideas at the nanoscale and see what we can achieve with less time and effort." ■



Dennis "Bones" Carpenter, who has taught photography courses at UK since 1973, describes himself as a maximalist. "I want my students to embrace complexity and follow their curiosity wherever it leads them."

Getting Down to the Bare Bones

Longtime art professor has a simple formula: embrace complexity

By David Wheeler

If, on a weekday afternoon, you happen to wander into the Reynolds Building, the old tobacco-warehouse-turned-art-studio-space on UK's campus, you might run into a thin, gray-haired art professor wearing Levi's and boots.

"Hi, I'm Bones," he'll say. That's right—Bones. Not Dennis. And please, not Professor Carpenter. He prefers Bones, whether you're a friend, a colleague, a student, or even a university president.

Why Bones? The answer traces back to his eighth-grade year, when he earned the nickname by being the skinniest kid in his class. "The nickname stuck, and I like it. It's easy to remember, non-threatening, and disarming," he says.

True enough, but soon after meeting Bones, you realize you've been tricked. The name, combined with his non-descript outfit of jeans, a denim shirt, and a wristwatch with no numbers on it, suggests meagerness. Simplicity. But this first impression belies something deeper. It hides, for a moment, a primary reason he has been revered by his students from the time he taught his first photography course here in 1973. Whereas some artists describe themselves as "minimalists," Bones calls himself a "maximalist." What students learn from Bones is not how to simplify their lives or their art, but rather how to embrace complexity and follow their curiosity wherever it leads them. "I want my students to realize art is a lot more complicated than it first appears," says Bones.

In the Classroom

One Wednesday afternoon in the fall, several photography students walk across the creaky floorboards of the Reynolds Building and gather to critique each others' photos. First up are photographs by Ariel Chollet, a senior majoring in art studio in the bachelor of fine arts program. Her photo series features a 12-year-old girl and her friends. These photos, which follow the girls around at a Halloween party, have a mysterious, almost unsettling quality. One photo features a girl wearing a way-too-big-for-her fur coat and sunglasses. "You're knocking on Diane Arbus' door," Bones says, referring to the well-known New York photographer whose work usually focused on people on the fringes of society.

"I don't think you're finished with this yet," he asserts, by which he means there is more complexity in her subject waiting to be explored. He suggests that Chollet capture her subject in as many environments—both physical and social—as possible. "The best way to show the uniqueness of something is to juxtapose it with its opposite," Bones says, legs crossed, leaning back in a 30-year-old chair with tattered orange upholstery.

Chollet later notes that this type of prodding by her teacher has helped her grow as an artist. "Bones taught me to make my art more complex by showing me the power of shifting the spotlight away from the star," she explains. "In essence, not to push what is already apparent to the viewer but to pinpoint the details that make a picture evocative. In doing so, I was forced to learn how to look within myself and feel what there was about the scene that needed to be captured."

"A photograph says as much about the photographer as it does about what the camera's pointed at," Bones says, later, at his home near the Kentucky River. "I think what most artists are trying to do, and maybe it's self therapy, is to create our own unified theory of life," his smile giving a slight lift to his tortoise-shell glasses. He leans against one of his work tables (a furniture style he calls "late poverty") while light streams in through the open windows under the 20-foot ceiling in his living room. "For me, it gets harder and harder, because it's like a snowball headed down a hill. As I continue making art, I just keep bringing every aspect of my life to it, and so it adds more and more layers."

Bones' artistic orientation comes partly from his personality and partly from his background. Before completing

an MFA in photography at the University of Florida, he earned an architecture degree from UK. "My architecture training affects my world view, without a doubt," he says. "In order to do well in architecture, you have to embrace complexity and organization. I don't make a huge distinction between the way one approaches designing a building and the way one approaches making photographs."

Computer Art

Bones was a pioneer in another arena that thrives on complexity: creating art with a computer. "Bones was one of the first people I knew who was incorporating image-making with the use of the computer," says Aimee Tomasek, who studied photography with him as an MFA student in the 1990s and is now a faculty member in the art department at Valparaiso University. "When he first started utilizing this equipment, you had to be very well versed as a computer technician in order to make any of

it work for you. There was no Adobe Photoshop in those days. He was very much on the cutting edge."

One of Bones' computer-created works, inspired by a trip to Costa Rica, involves multiple layers: maps of the country, photos of a fishing trip, images of fish, and nautical shells, among other things. Lee Thomas, a Lexington-based commercial photographer and former

student of Bones, admires his ability to create complexity through layers. "His photographic canvas is of two dimensions layered with imagery of two and three dimensions," Thomas says. "This creates intertwining foreground, mid-ground and background. For the viewer it creates motion and depth to look at, around and through. And then there's the mystery of the image's intent and meaning."

A Healthy (Artistic) Curiosity

When you walk into Bones' home, the first thing you're likely to notice are many bookcases, all crammed full of books. The authors housed there include Descartes and Dante, and subjects range from investment strategies to world travel. Bones thinks good art can come from inspirational sources other than visual art, and he describes the work of a friend, Robert May, who made photographs with multiple exposures that resulted in "herky-jerky" images.

"His inspiration for the images," says Bones, "was a love of Robert Frost's poetry, symphonic music, and the

"My art is all-consuming; it's a way of life. There aren't enough hours in the day for me to explore everything I want to explore."

—Dennis "Bones" Carpenter



One of Bones' computer-created works, inspired by a trip to Costa Rica, involves multiple layers: maps of the country, photos of a fishing trip, images of fish, and nautical shells.

organ music of Bach. Musicians viewing his work might sense its muses, but most casual observers would not get it until the artist pointed it out." May, Bones adds, was a great supporter of the arts, making one of the largest bequests ever to the UK Art Museum, which sponsors a lecture series in his name.

Bones brings this cross-fertilization of the arts into the classroom. "In my first photography class with him, he thought it might open our artistic minds to read something creative, so our required reading was Tom Robbins' *Wild Ducks Flying Backward*—a collection of short stories, essays and poems," says former student Lee Ann Paynter, who is now pursuing an MFA in the photography and media program at the California Institute for the Arts. "Most

of the class expressed some sort of dismay in the beginning. But discussions proved insightful and intriguing. It opened up territories of ideas, which led me personally to dig deeper into a project that I'm still working on."

Paynter says Bones' curiosity causes him to constantly seek knowledge in its many forms. "He has an appreciation for intelligent humor and wit, and a real love of language—all things that are well crafted."

"My art is all-consuming; it's a way of life," Bones says. "I'm baffled when I hear about people who retire and don't know what to do with themselves—people who need to be entertained all the time. That's foreign to me. There are not enough hours in the day for me to explore everything I want to explore." ■

FRESH-BREWED RESEARCH

Fair trade coffee serves up benefits for Guatemalan farmers

By Jeff Worley

There's something about coffee. It's a kick-start, a warm promise that the day ahead might not be so bad after all. Coffee, well, it perks us up.

But whether you speak java jive and order, as the Steve Martin character did in *L.A. Story*, "a double decaf, half caf, with a twist of lemon," or take your coffee "mean and black," as my father did, it may not enter your mind to wonder exactly where these magic beans were grown, or under what conditions, or if in the hillsides to Hills Brothers deal the coffee farmer made out OK financially.

Sarah Lyon, an assistant professor of anthropology at the University of Kentucky, has given coffee a lot of thought, focusing her work on how fair trade practices have impacted coffee-producing communities in Guatemala. Her major findings to date are that fair trade has enabled farmers to make a reliable income from their labors, pay for their children's education, and—through coffee co-ops—gain political stability.

But why Guatemala?

"As an undergrad in 1998, I got very fired up by a couple of my anthropology professors at Smith College, so decided I wanted to learn Spanish. They told me Guatemala was a great place to learn because it was inexpensive to go to a Spanish school there. Coffee has historically been Guatemala's leading export, so I suddenly found myself immersed in a major coffee culture—with all of its financial contingencies and challenges," Lyon recalls.

A major concern of farmers in rural communities was how to make a sustainable living from the coffee they produce. "I started to think more and more about this when I came back to the United States for graduate work at Emory University," says Lyon in her Lafferty Hall office, where she is surrounded by neatly shelved books, and a small, colorful gallery of framed photos of Guatemalan village locals and coffee farmers. "Fair trade coffee was just taking off in the U.S. as a topic of interest and conversation."

"Fair trade"? Exactly what is that?

"Well, fair trade basically means the farmers, the producers, are paid a fair price for the product," Lyon says. She explains that this price is determined by The New York Coffee Exchange. Fair trade coffee growers are guaranteed a minimum price of \$1.25 per pound of coffee. They also receive a 10-cents-per-pound fair trade premium that they are supposed to invest in their coopera-

tive or the community. This translates into \$1.35/pound for fair trade coffee.

"If the world coffee market price rises above \$1.25 per pound, then the fair trade minimum price rises to meet whatever the market price is," Lyon says. The farmers will still receive the 10-cents-per-pound premium, so they are always guaranteed at least 10 cents a pound above the market price.

With such a puny difference between the market price and the fair trade price, why do these farmers continue to work long, hard hours producing coffee?

"They farm coffee because it is a perennial tree crop, and they have invested significant time and money in cultivating their coffee parcels over the years," Lyon explains. She smiles. "Many cooperative members referred to their coffee plots as 'children' that they have lovingly tended for decades. It would be prohibitively expensive for them to rip out all of this coffee. And they continue to grow coffee, because, unfortunately, there is no viable economic alternative for them."

This small bump in income is one positive result of fair trade coffee practices in Guatemala, but as an anthropologist Lyon was interested in finding out fair trade's broader impact as a form of long-term community development for Guatemalan coffee farmers and their children. In 2001 and 2003, she spent 14 months researching fair trade's benefits, and limitations, in a Mayan community on the shores of Lake Atitlán in central Guatemala. "I wanted to find out how participation in this global market shapes daily life in this community, how it changes individual and group identity." Her research was focused on a cooperative—an organized group of coffee farmers—in this community.

"I started off by interviewing the cooperative founders," Lyon explains. "I did a lot of what we in anthropology call semi-structured interviews, which would begin with a few specific questions, but then the discussion would go where it flowed." She also interviewed 60 members, attended all the cooperative meetings, learned how to grow coffee,



Sarah Lyon spent 14 months researching fair trade's benefits and limitations in a Mayan community in central Guatemala.

how to take care of it, and how to pick it.

Lyon abruptly interrupts herself. "I wasn't a very good picker, but I gave it my best shot," she says, laughing. She adds that there's an art to making high-quality coffee. "You have to pick just the right beans at just the right time."

The Benefits of a Fair Trade Co-op

A few more pennies a pound for coffee farmers doesn't seem like much, but Lyon says this slight difference is important for the growers. "I found that the higher income enabled cooperative members to continue repaying their debts, maintain their standard of living, retain their landholdings, and pay for their children's education during a period in which many of their less fortunate neighbors were forced to sell their land and withdraw their children from school."

The importance that co-op members place on their children's education contrasts sharply with their own childhoods, which in general were devoted to productive labor in fields, homes and *fincas*.

"Fair trade has enabled farmers to make a reliable income from their labors, pay for their children's education, and—through coffee co-ops—gain political stability."
—Sarah Lyon

(large plantations), not formal learning. Nineteen percent of the surveyed cooperative members never attended school and 42 percent completed only three or fewer years, meaning many possess only basic literacy and mathematical knowledge. Only 10 percent of surveyed cooperative members completed high school. Despite their own low levels of educational attainment, 42 percent of members have at least one child who has completed secondary school and works in an office, as opposed to pursuing traditional agricultural work or caring for the home.

But the primary benefit for co-op members is political stability. Lyon found that the very act of establishing a cooperative organization has allowed groups of Guatemalan farmers to overcome the oppression of a government that for years regularly attacked organized groups of citizens, especially indigenous communities during the country's 30-year-long civil war.

"Co-ops were often targeted by the army as being Marxist or anti-government, but when members in the cooperative formed relationships with international visitors through fair trade, members felt protected due to their new international connections," explains Lyon. "The coffee roaster, from the United States, came to visit once a month to check on the coffee quality. What I heard from many of the farmers I spoke with was that the co-op gave them a sense of security and a space for an emerging participatory democracy."

Additionally, these connections with international roasters and coffee importers in the United States and Europe provide feedback to the farmers to help them improve coffee quality. And farmers within an organized fair trade market are more likely to have access to credit, since participation in these markets tends to "validate" these farmers in the eyes of lenders.

Lyon also discovered some limitations in the effectiveness of fair trade cooperatives. Although they had clearly helped local farmers, she explains, farmers still have some concerns about being well enough compensated for their work. "Eighty-three percent of farmers I interviewed said that prices weren't high enough," she says. "It wasn't like they wanted four times what they made—they wanted 10 to 15 percent more, a modest increase."



The wife of a co-op member dressed in San Juan's traditional clothing, *traje*.

"The end cost to the consumer is simply mind-boggling to the farmers I talked with—it's really hard for them to comprehend. They would say, 'I don't understand. We sell our coffee to the buyers in the United States for a \$1.41 a pound, and yet if we went to a coffee shop in the United States to buy one single cup of coffee, it would cost three dollars! How does that work?'" Roasters she interviewed are quick to point out the numerous costs associated with transporting, roasting, packaging, and marketing specialty coffee in the United States, but even when this process was explained to the farmers, they still felt undercompensated.

Her study also revealed a gender limitation. She found little empirical evidence of a significant impact on gender equality among producer groups. "It's a mixed bag," Lyon admits. "In some communities, it made no impact on existing gender inequities; in other communities, there is space for women to participate." Traditionally, agricultural work in Guatemala has been considered unacceptable for women.

Have Lyon's years of research in Guatemalan coffee communities changed her coffee-drinking habits or tastes?

"Definitely," she says, enthusiastically. "I'm not going to lie. I'm very partial to Central American coffees. The volcanic soil and the high altitude produce very bright-tasting, high-quality coffees."

How many cups a day?

"Oh, I really shouldn't comment on that," she laughs. "Let's just say I probably drink too many." ■

Little Hemlock HORROR

Saving a Kentucky Treasure from a Sap-sucking Bug

By Alicia P. Gregory



William M. Ciesla, Forest Health Management International, bugwood.org

The scent of moist earth and a rush of cool air on your skin tell you water is nearby. You look up, struggling to make out the sky. The dense canopy of 100-foot-tall trees allows little light to penetrate to the rocky soil. “When you walk into a hemlock forest, you can smell, feel and hear that you’re in a different world,” says Lynne Rieske-Kinney, in a warm, alto tone. “The air temperature is considerably cooler, the light is much more diffuse, vegetation on the forest floor is minimal. Hemlocks are very tall, very old trees.”

The oldest recorded specimen of Eastern hemlock, an evergreen tree native to eastern North America, lived 554 years. Eastern hemlocks range from Minnesota to Alabama, but in Kentucky—specifically in the Appalachian Mountains of Eastern Kentucky—they are not widespread. “Instead of vast tracts of hemlock, we have fragmented pockets along streambeds, mountain ridges, road cuts, and ravines. Nevertheless, Eastern hemlocks are extremely important ecologically,” Rieske-Kinney says, with a twinge of sad-



Lynne Rieske-Kinney, professor of forest entomology at UK since 1996, leads the fight against the sap-sucking foreign invader—the hemlock woolly adelgid—that threatens Kentucky's Eastern hemlocks.

ness that hints at the reason this University of Kentucky entomologist knows so much about these trees.

Hemlocks have an important impact on the forest because they regulate stream temperature and chemistry, and they control sedimentation. Their acidic needles alter the soil around the trees, affecting the pH of nearby streams. Invertebrates, including flies, leeches, worms, and crayfish, living in the water feed on the needles. "In Eastern Kentucky these hemlocks are often the only evergreen present, so they also provide cover and habitat for a number of different songbird species," Rieske-Kinney says.

Kentucky's hemlocks are under attack from a sap-sucking, foreign invader—the hemlock woolly adelgid. Just a millimeter in size, these flat, black insects pack a big punch. Within four to six years of infestation, most

Eastern hemlocks will die. Rieske-Kinney, her colleagues, and graduate students are evaluating this threat by mapping the distribution of Kentucky hemlocks and adelgid-infested trees, and predicting where the adelgid will head next. Her strategy is to fight them with chemicals and predatory beetles. In a worst-case scenario, her team is also forecasting the future of Kentucky's forests without Eastern hemlock.

Bad things come in tiny packages

Trees are in her blood, Rieske-Kinney admits, but she's a realist: "We can't save all the hemlocks.

"I grew up on a Christmas tree farm in Michigan. I was always outside, and actually I'm more interested in forests than I am in insects." She practically whispers this last part, half-joking, with a glance toward her open office door, as if it wouldn't be good for her entomology colleagues to overhear.

She earned her Ph.D. in entomology at the University of Wisconsin and did a postdoctoral fellowship at Colorado State before joining the UK entomology department in 1996. As a professor of forest entomology, Rieske-Kinney also holds an adjunct appointment in the Department of Forestry. "My slant toward insects is their interaction with plants. That's how I got into invasive species." These exotic plants, animals and pathogens can result in loss of native species, degradation of soil, decreased groundwater levels, destruction of wildlife habitat, and increased risk of wildfires.

The hemlock woolly adelgid, native to Asia, is a Top 20 kind of destructive bug. It recently made the UK Invasive Species Working Group's list of the "Top 14 Invasive Species in Kentucky." Rieske-Kinney is on the steering committee of the group, which began in 2006—the same year the adelgid was first spotted in Kentucky.

"In the 1950s in Richmond, Virginia, the hemlock woolly adelgid hitchhiked in on a Japanese hemlock, a species that is fairly resistant to the adelgid," Rieske-Kinney explains, leaning back in her chair. "Fast forward 30 years. Scientists suspect hurricane winds carried the insect to Long Island. It hopped over to Connecticut and became a raging forest pest, decimating large, contiguous tracts of Eastern hemlocks. It's been working its way back south ever since."

In March 2006 the adelgid was discovered in Kentucky in Harlan County by J.D. Loan, an exotic pest surveyor



Michael Montgomery, USDA Forest Service, bugwood.org

(Inset) An adult hemlock woolly adelgid. At less than a millimeter in size, these insects pack a big punch—within four to six years they can kill a 100-foot-tall Eastern hemlock tree.

The bug attaches itself to the leaf cushion (at the base of the needle) to feed. It surrounds itself with white, woolly sacs that protect it from predators and temperature extremes.

for the Office of the State Entomologist. His boss, John Obrycki, who has served as state entomologist and chair of the UK entomology department since he came to UK in 2003, says Loan could have easily missed this important first sighting. “He was taking a little road that winds up Pine Mountain, and he happened to see hemlocks beside the road. He got out and found the telltale signs of an adelgid infestation. I saw where those trees are located. It would have been extremely easy to just drive right by.”

So what are the chances of finding a bug the size of a pinhead in a 100-foot-tall tree? Rieske-Kinney states that just because you don’t find the insects at the base of the tree doesn’t mean they aren’t there. To explain where you have to look, she gives a crash course in adelgid physiology.

Adult adelgids do little more than sit and eat. In fact, once they start to eat, they never move again. They insert

Chris Evans, River to River CWMA, Bugwood.org

their mouthparts, a long proboscis, into the leaf cushion at the base of the tree’s needles. There they feed on a type of cell called the xylem ray parenchyma, which contains photosynthate—a chemical byproduct of the process of converting sunlight into carbohydrates and oxygen. She explains, “As it feeds and grows, the adelgid produces white flockulance”—something that looks like white, woolly sacs—“which serves to protect it from predators and extreme temperatures. Adelgids reproduce asexually, with two generations per year and up to 300 eggs at a time.” When these babies, called crawlers, travel to find their meal ticket, they are easily carried by the wind and brushed onto the feathers of songbirds as they fly from hemlock to hemlock.

Rieske-Kinney tucks her curly hair behind an ear as she says, “So far we have not discovered any native natural enemies that can regulate adelgid populations. Infestations are fatal because the insects remove photosynthetic material, resulting in needle loss, dead branches, crown thinning, and eventually tree mortality. On the forest level we’re starting to see all these browned canopies of dying

hemlocks.” And the adelgid infestation is spreading at the alarming rate of 15 miles per year.

In work funded by the Kentucky Agricultural Experiment Station, the U.S. Forest Service, and the Kentucky Science and Engineering Foundation, Rieske-Kinney is leading the charge to stop the infestation. The first step: locate hemlocks and track the spread of the adelgid.

Mapping Kentucky’s “hidden” resource and its nemesis

“When we started we really didn’t know how much hemlock was in Kentucky,” Rieske-Kinney says. “Since it’s not an economically important resource—like our hardwood timber—most of the databases grossly underestimate it.” So in 2006, her forestry colleague, Assistant Professor Songlin Fei, and the graduate student they co-advise, Josh Clark, set out to create an accurate distribution map of hemlock. Clark used remote-sensing technology (satellite imagery and digital environmental data), combined with on-the-ground GPS points of locations where the state entomology staff had recorded the presence of adelgids, to create two maps: one for the trees and one for the insect.

Clark, who earned his B.S. in biology from the University of Central Arkansas and is putting the final touches on his entomology master’s thesis, describes his work: “I built the insect models based on where the tree models predicted the hemlocks were. Those models located hemlocks using

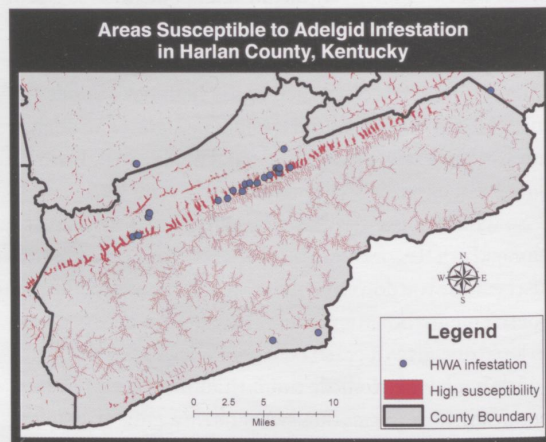
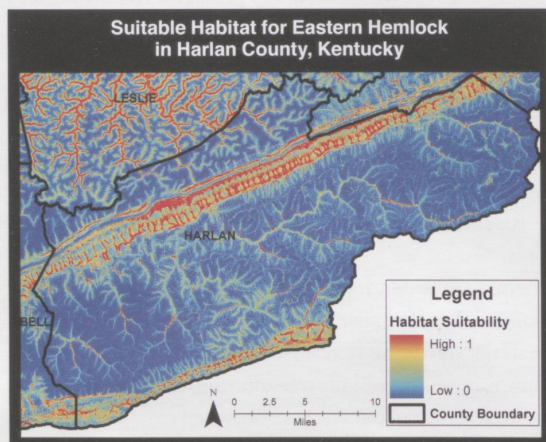
variables like slope, elevation, soil type, moisture index, surrounding vegetation, and distance to streams, roads, trails, power and phone lines, and urban areas.

“We are in the early stages of the invasion.” He scratches his bearded chin as he explains, “Because we know birds use corridors such as streams, roads and abandoned rail lines, and adelgids have been spotted in those areas, we can make an educated guess that the insects are being carried by birds. If we extrapolate that to the 13 counties where we’ve found the insect, we can project that similar areas should be highly susceptible to infestation. These maps will help people fighting the adelgid to see where to go first—the areas of highest susceptibility located closest to known infestations.”

Fighting the adelgid

So what’s the game plan? A two-pronged attack—injecting chemicals and releasing predatory beetles.

Two dozen faculty, graduate and undergraduate students have spent a series of long, exhausting days tramping through the forest. Carrying two-foot-long metal injectors—that pump a chemical called imidicloprid into the soil at the base of a hemlock—and hauling water to mix with the chemical, this volunteer army, along with state park officials and land managers, has treated thousands of trees in the Pine Mountain State Forest, Blanton Forest, Cumberland Gap, and the Lilley Cornett Woods in Eastern Kentucky.





Kentucky State Entomologist John Obrycki holds a bucket containing thousands of *Laricobius nigrinus*. These predatory beetles, imported from the Pacific Northwest, will seek out and feed on the hemlock woolly adelgid. In combination with chemical treatments, the UK team is releasing these beetles to quell the adelgid infestation in key areas of Eastern Kentucky.

"The Forest Service supplies the chemicals, and we supply the injectors and the workforce," Rieske-Kinney explains. "We inject the chemical around the perimeter of the tree and, theoretically, it protects the tree for three to four years. It effectively kills the adelgid, and we've also seen some striking regrowth of the branch tips, as soon as the next growing season. It certainly works, but it is labor-intensive and expensive."

Obrycki echoes her words, calling chemical injections a stopgap measure. "It buys us time," Kentucky's chief entomologist says, shrugging. "We're targeting trees by buildings and trails, trees that would be hazardous if they came down. But chemicals aren't our only weapons against the adelgid. We're also importing natural enemies."

Across Tennessee, Georgia and Virginia where outbreaks are raging, there are "rearing facilities" that breed beetles to prey on the adelgid. "Scientists at these facilities have already done extensive testing in terms of what these beetles will and won't feed on. These are very specific—they only eat adelgids," Obrycki explains.

So there's no danger of a sci-fi-type beetle outbreak? Rieske-Kinney says, "Not likely. The days of biological control agents running amok are behind us, because today's screening methods are so much more effective than they have been in the past. These are adelgid-specific predators. And the only other species of adelgid in Kentucky, the pine bark adelgid, is very scarce because its host tree—the white pine—is not abundant here."

In Kentucky two species of beetles have been released: *Sasajiscymnus tsugae*, a Chinese beetle, and *Laricobius*

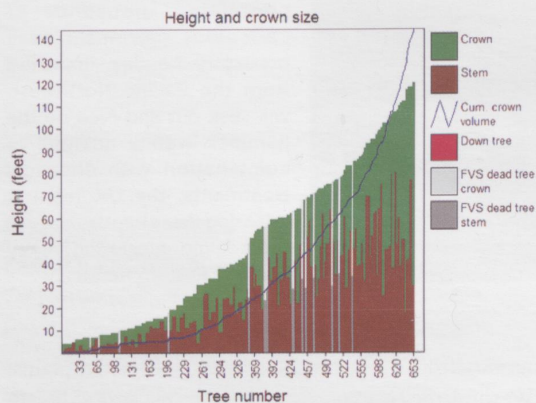
nigrinus, from the Pacific Northwest. Obrycki explains: "We think the *Laricobius* is our best bet, because although the colder weather conditions in the Pacific Northwest help the hemlocks there, and that species of hemlock seems to be less susceptible to the adelgid, these beetles also seem to play an important role in protecting the trees."

But, he notes, predatory beetles don't make an overnight impact. "It can take five to 10 years for them to establish themselves, and in that time you hope that the infestation doesn't reach such a high level that the tree can't recover. That's why we're doing a combination of chemical injections and beetle releases."

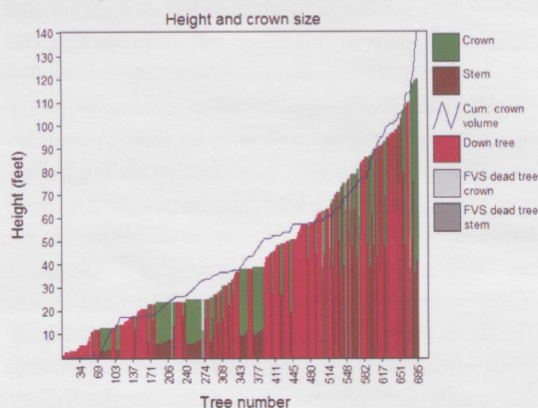
Obrycki and Rieske-Kinney agree it's a balancing act. "The idea is to release the *Laricobius*, which is not a highly mobile insect, then use chemicals on the surrounding trees to reduce the adelgid populations," Rieske-Kinney says. "By the time the beetles establish themselves and disperse from tree to tree, the insecticide levels will be low enough that the beetles can handle it and go after the remaining adelgids. We're trying this along the leading front of the infestation. We think it's going to work." Other states have had success using beetles.

Since 2007, UK researchers have released 50,000 to 60,000 beetles. "That sounds like a lot—and it is a lot," Obrycki says with a wry smile, "but these beetles are small. They're maybe twice the size of the period at the end of a sentence. When you put them into a forest and they have unlimited movement, they eventually start to make a difference."

20-year Prediction without Adelgid



20-year Prediction with Adelgid



Imagine a forest without hemlocks

Only time will tell how many hemlocks can be saved, but time is not on the hemlock's side. "It's not a happy picture," Rieske-Kinney reveals, getting out two graphs. Both predict what the forest will look like in 20 years—one without the hemlock woolly adelgid and one with the adelgid infestation. "According to Heather's projections, we can expect to lose the majority of our hemlocks within a decade."

Rieske-Kinney's graduate student Heather Spaulding, like her mentor, is a Michigan transplant. She moved south for undergraduate work at Louisiana State University at Shreveport, and last December earned her master's in entomology from UK. Spaulding's forest models are striking.

"In two decades if we didn't have the adelgid, we'd see many tall trees with dense crowns. But with the adelgid in 20 years the structure is drastically different. Lots of relatively small trees and a sparse canopy with many gaps."

Obyrcki adds, "In the short term, areas like the Pine Mountain State Park will suffer. Losing the natural beauty of those 400-year-old trees would be devastating for the park." But beyond the loss of beauty and potential loss of tourism, he stresses, is the frightening ecological future. "In some of the places where these hemlocks grow, it's a wonder anything grows at all." He measures out two inches with his fingertips and says, "There's this much soil on top of rock. What's going to take that hemlock's place in terms of keeping back that soil? And what's going to happen to the invertebrates and fish downstream when the water temperature rises?"

Rieske-Kinney uses the words "heartbreaking" and "disturbing" to sum up these projections. "The forest will go on, but it will be the end of our hemlock forests as we know them today. We're working to save as many trees as we can." ■

2009-2010

University Research Professors

Gang Cao: Spinning, But Keeping His Balance

By David Wheeler

Gang Cao believes in balance. A physics professor in the College of Arts and Sciences, Cao enjoys curling up on the couch after a hard day's work, glass of wine in hand, classical music on the stereo. "There are so many fascinating, exciting things going on in the world," says Cao, whose parents are comparative literature professors in China. "As an intellectual, as a human being, you should know more than simply what you are doing at work."

Before explaining his research, Cao places his hands on his tidy desk. The sleeves on his crisp white shirt are rolled up evenly.

His belief in balance extends to physics—and specifically to an emphasis on both the study and creation of materials used in science. His pioneering approach has attracted a \$4.5 million National Science Foundation grant for UK's Center for Advanced Materials. "Our unique niche is that we are going to focus on novel materials synthesis and characterization—both the creation and investigation of materials. And this approach is still largely missing in the United States."

"There is this biased view that making materials is a low-level job, so scientists don't need to do it," he says, leaning back in his chair. "But if you want to be a good materials scientist, the first thing you need to know is how to *make* materials."

Take, for example, "spin valves"—a nano-level technology that is part of a \$100-billion industry called spintronics. Spin valves, which control the direction of an electric current

through magnetism, are used as magnetic sensors in devices such as computers and iPods. Spin valves can be created in artificial thin films, but they can also occur naturally in crystal formations. Cao not only creates spin valves synthetically, but also studies them in laboratory-grown crystals.

The process of synthetically manufacturing a spin valve is complicated and costly though, requiring expensive equipment, powerful vacuums, and nanoscale patterning of artificial thin films. And after all that trouble, the performance of the resulting valves is sometimes difficult to control.

Responding to this problem, Cao made two important discoveries about spin valves that were published in 2008 in *Physical Review Letters*. First, he bypassed the complicated synthetic manufacturing process with his team's discovery of naturally manufactured single crystals that demonstrated the properties of spin valves. He calls it "the bulk spin valve effect." Second, Cao found through research in his lab that these crystals were cheaper and easier to make, and had a stronger spin valve effect than synthetically produced spin valves.

When discussing his research, Cao, who came to UK in 2002, makes sure to credit colleagues with whom he has collaborated, including Lance DeLong, Joseph Brill, Sean Parkin, and Kwok-Wai Ng. "I am also very fortunate right now to also have four excellent graduate students and strong departmental support," he says.

Discoveries such as the bulk spin valve effect could help this country regain its footing in materials research. "Whoever controls the development of new materials controls science and technology," Cao says with a confident smile. "If you can develop better materials, then you can make better iPods, better computers, better cameras."

Cao's scientific ambition springs from the strong obligation he feels toward his parents. "They expected me to be successful in science," he says. After earning a bachelor's degree at Wuhan University in China, Cao came to the United States to study physics at Temple University. "I studied so hard," he says. "For the first couple of years, it was for my parents. I didn't want to let them down. Then, when you really get into physics, you just want to spend every minute in the lab."

But now Cao doesn't tie himself to the lab, because of a "major, wonderful" change in his life. "We have three sons—the youngest two years old—so I have to put my work in a different perspective these days," he says with a laugh. ■



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.

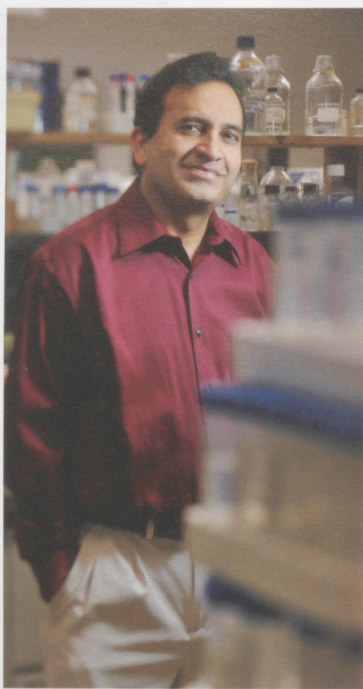
Subba Reddy Palli: Big Discoveries from Tiny Creatures

Subba Reddy Palli grew up in a small village in India. After school, he would often go to the family farm to help his father as he tackled the challenges of farming. In talking with his father, Palli learned that insects are the farmer's major nemesis, and even at a young age envisioned himself studying insect control to help his father and other farmers.

As an entomology professor in UK's College of Agriculture for the past seven years, Palli has made significant strides toward increasing the power of insecticides. However, farmers aren't the only people Palli is potentially helping. What started out as an idea to kill bugs in the field of his native India may also save cancer patients' lives.

Cancer treatments such as chemotherapy kill cancer cells but also harm healthy cells in the process. With \$800,000 in funding from Rheogene, DowAgrosciences, and the Kentucky Tobacco Research and Development Center, Palli developed "gene switch" technology, which triggers protein production only in the cancer cells to kill them so they can't proliferate and form a tumor. "Using the receptors I cloned from insects, it works just like a light switch," he says. "We can control when this gene is turned on and off." So in the future, a patient with a small tumor could get a drug injection that flips a switch and releases a protein to kill the cancer cells. The drug, a chemical ligand, would be injected directly into a tumor.

Eventually, this same technology may also have applications in treating diabetes. For diabetic patients, the



chemical might be administered in the form of a pill, instead of an injection, to help control insulin production.

As for the research you are more likely to expect from an entomologist, Palli figured out a way to fight insect pests that often develop resistance to the insecticides most commonly used to kill them. Over time, the insect's body increased the production of enzymes that improved their ability to "detoxify"—metabolize and excrete—the insecticide.

Palli discovered that this problem can be solved with a new technology called RNA interference. RNA stands for ribonucleic acid, a molecule with numerous functions. "We can take small double-stranded RNAs, mix

them with the insecticides, and feed them to insects," he says, leaning away from his glowing computer screen. "That prevents the increase of these enzymes, so the insects won't be able to degrade insecticides. Therefore, they will die from the same insecticides to which they are resistant right now." Palli has already shown that this strategy works in red flour beetles, who love stored grain products. He is testing the strategy on other insect pests such as the Colorado potato beetle and bed bugs.

Palli's research was made possible by \$3.8 million in funding from the NIH, NSF and USDA. Palli is thrilled by this support, but admits he couldn't have accomplished what he has without his talented lab team, including 10 postdoctoral fellows, five graduate students, and eight undergraduate students.

Though the general public is likely to be most excited about the human health applications of his research, Palli is especially enthusiastic about the promise of helping farmers like his father. "The technologies we're developing at UK can be adapted by scientists all over the world to kill insect pests. When I visit different countries, I give seminars and talk to people. They know what we are doing, and they understand the value of our work here. If our work can one day help reduce hunger in the world by increasing food production, I will be very pleased." ■

Kevin Sarge: "Sumo" Wrestling with Alzheimer's Disease

Kevin Sarge is exactly what an interviewer hopes for. He answers questions precisely and after careful reflection. No question is too simplistic or off-target. When he talks about his research, he puts you at ease: Sarge, a professor of molecular and cellular biochemistry in the College of Medicine, is a patient man.

That patient approach to his work is part of what makes him a good scientist. Sarge describes the scientific process as requiring much hard work, but adds that if scientists persevere, their work can definitely pay off. Sarge's research has been funded by the NIH, published in prestigious journals such as *Science* and *Nature*, and is now officially recognized at UK by a University Research Professorship. When he was notified of this award, Sarge says he was both surprised and honored. "I know there are many outstanding researchers here at UK who have made really important discoveries and are very worthy of being recognized for their accomplishments."

Sarge attended Penn State in the early 1980s, followed by graduate school at North Carolina State before taking a postdoctoral fellowship at Northwestern. Since coming to UK in 1993, he has conducted research that holds promise in the fight against Alzheimer's disease. "I like studying disease processes at the level of what is going wrong with the proteins and other biomolecules involved," he says.

"Because if you find protein differences in the disease state, then you can envision straightforward approaches that could compensate for the difference and perhaps correct the disease."

Knowing his Alzheimer's research is complicated, especially for a non-scientist, he walks over to a dry-erase board to create a visual aid for what he's about to discuss. Sarge draws a horizontal rectangle about the size of a ruler, which he labels "APP"—amyloid precursor protein—something all of us have in our body. "APP starts off as one protein," he says. However, certain enzymes sometimes come along and clip the protein into pieces, creating different proteins from the original APP.

To visualize this, imagine APP as a ruler. Now imagine someone cutting the ruler at the 8-inch mark and the 9-inch mark. In scientific terms, this is called "cleaving." Sarge explains: "It's like taking a pair of molecular scissors and getting the little piece out of the whole protein." Enzymes are generally known for their role as catalysts, and two particular enzymes, γ -secretase and β -secretase, cleave the APP, essentially cutting out a section of the "ruler."

In this case, the "little piece," the section between the 8- and 9-inch marks on our imaginary ruler, is called the A β peptide. Because many scientists believe that this peptide causes Alzheimer's disease, any discovery of a way to block or delay the cleavage events that lead to the creation of A β peptide is welcomed. That's what Sarge hopes his research will do. His team discovered a particular protein, called a SUMO protein, which appears to block β -secretase from cleaving, effectively stopping the creation of the A β peptide. This SUMO protein is attached to APP by a bonding event called sumoylation that regulates many aspects of normal protein function.

"If we could find a way to increase SUMO protein attachment to APP, this could conceivably delay the onset of Alzheimer's."

For Sarge, the most difficult and the most rewarding aspects of his research go hand in hand—in the form of articles written for peer-reviewed scientific journals. He describes the process as often being long and complicated, with many back-and-forth revisions. But when he was notified by email that he had an article accepted in the journal *Science*, he says, "I felt like I was floating."

Because it's difficult to know which scientific experiment will lead to a solution to which problem, Sarge stresses the importance of general science in the quest to cure diseases. "We can't just be doing disease-specific research," he says. "You've got to take a more general approach, because, you never know, your findings may be hugely important in the battle against many different diseases. You never know where the next big result is going to come from." ■



Karin Westlund High: Progress in the War against Pain

ainfully shy as a ninth grader, Karin Westlund High stepped on the stage, pulled out her note cards, and presented her science fair project—a comparison between pharmaceutical-grade penicillin and the mold growing on an orange. This was at the regional science competition in Austin, Texas, and the room was packed with students and teachers.

"I'd been on the stage since I was three years old, doing ballet, tap and jazz," says High, still soft-spoken even now that she is a professor in the UK College of Medicine's Department of Physiology. "But when you are on a ballet stage, the lights blind you to the audience—you can't see any faces. The regional science fair was different: I could see a hundred or so unfamiliar faces judging my every word."

ers. Using an animal model, her team discovered that a pinpoint lesion made by a microscalpel on the spinal cord eradicates abdominal cancer pain. The discovery was published in the 1999 *Proceedings of the National Academy of Science*. Since then, in 44 case reports around the world, doctors have documented successful performance of this procedure on patients.

The procedure, which has not yet been widely adopted in the United States, is considered to be radical because it involves making a cut on the spinal cord—something that cannot be undone. The medical establishment in the United States is uncomfortable with curing pain in this way and prefers to prescribe drugs instead, High says. Previously, pain has returned after cuts were made in other places in the spinal cord. This, however, has not happened in patients with this abdominal surgery, some living for up to three years after the procedure.

High's second major discovery involves gene therapy. Her laboratory used an animal's natural ability to make proteins to overproduce an opiate at the location of the pain. Her experiment involved injecting a harmless, inactive herpes virus into lab rats suffering from pancreatitis. High not only demonstrated that the animals had less pain after the procedure, but she also encountered a surprise finding.

"The opiate repaired the damaged tissue, which was totally unexpected," says High. She published different aspects of this experiment in four research journals: *Molecular Pain*, *Molecular Therapy*, *Gene Therapy*, and *The European Journal of Neuroscience*. High says it is too early to use this experimental treatment with patients,

but the procedure is being studied in a Phase I clinical trial. David Fink, chief of neurology at the University of Michigan and lead investigator of this clinical trial, says, "Very interesting results so far."

High's most recent discovery shares certain characteristics with the nicotine patch. In cooperation with a Lexington biotechnology company called AllTranz, Inc., a pharmaceutical company founded in 2004 by UK's Audra Stinchcomb and based in Lexington, High created a transdermal patch containing a chemical that can stop pancreatitis pain. The chemical comes from the marijuana plant, but is non-addictive and non-psychoactive.

"It's a practical approach to reducing pain," says High. Unlike her first two major discoveries, the patch has a good chance of catching on in the United States for two reasons: it's a pharmaceutical approach, which the American medical community prefers, and the public is already accustomed to the idea of a transdermal patch, thanks to the nicotine patch.

When High looks back on her career, she can't help but think about the junior high science teacher—Linda Baines—who pushed her to excel when she was a shy teenager. And one further goal of High's is to inspire the next generation of scientists. One of her former students, Kathleen Sluka, is now a professor at University of Iowa's medical school and directs the pain laboratory there. "It's very rewarding to see Kathleen become a major research player in the field of pain," High says. ■



But she won this competition, and then the Ford Future Scientists Award in 1967. She knew she was meant to be a scientist. Today, High is a highly regarded researcher in the field of pain studies. In fact, she has made so much progress in the field that she received the American Pain Society's Lifetime Achievement

Award last May. "I was very gratified by the award, but I'd like to think I have quite a few more years of work left to offer," she says with a quiet laugh.

High's first major discovery was a cure without any side effects for the debilitating pain of abdominal can-

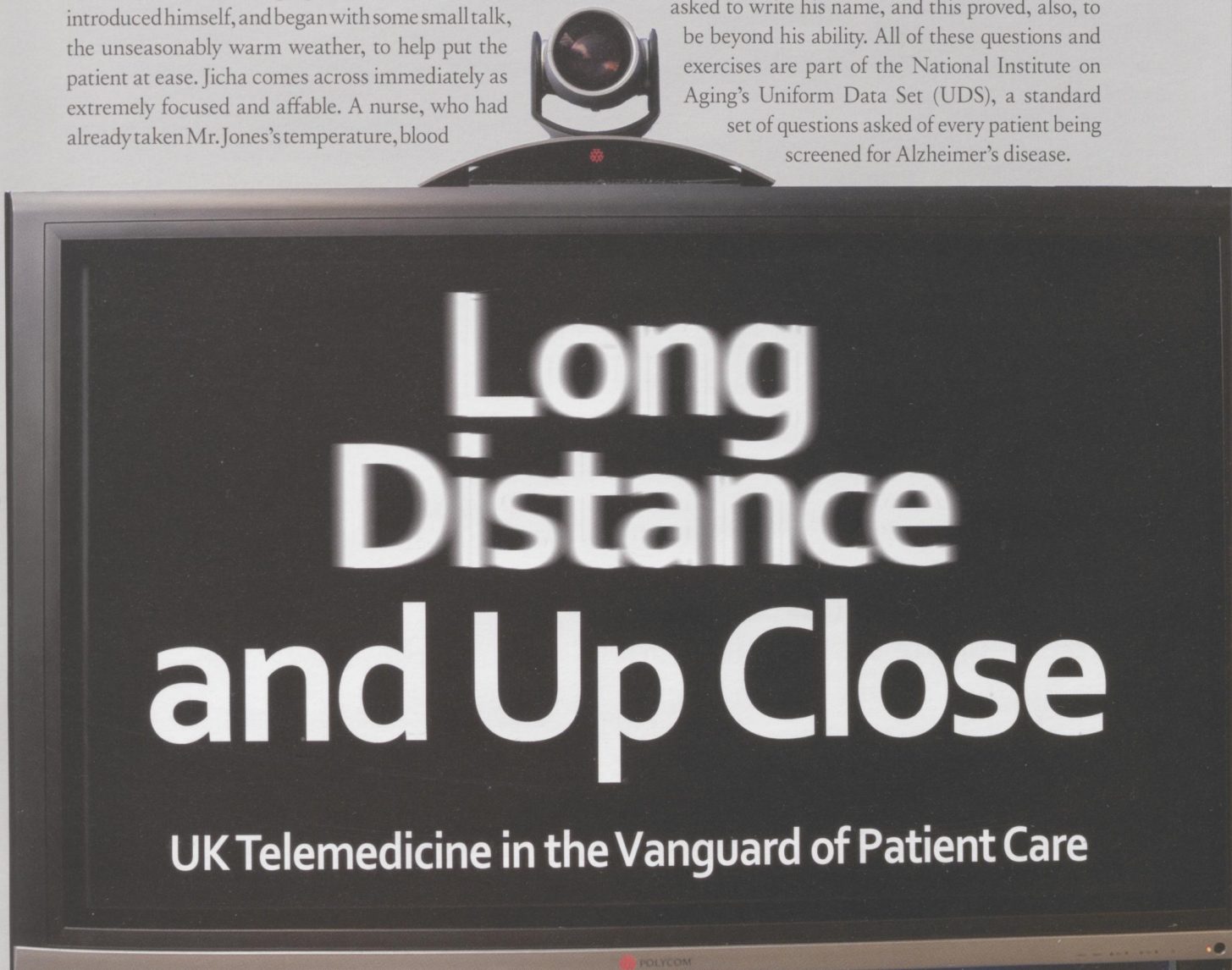
By Jeff Worley

The elderly patient and his wife had been waiting only a few minutes when Dr. Gregory Jicha walked into the room. The couple had come for a consultation. Mr. Jones (the name we'll use), 91, was having memory problems, and his wife wanted him to talk with an expert on aging and memory.

Jicha, an assistant professor of neurology at UK's Sanders-Brown Center on Aging, sat across from the couple, introduced himself, and began with some small talk, the unseasonably warm weather, to help put the patient at ease. Jicha comes across immediately as extremely focused and affable. A nurse, who had already taken Mr. Jones's temperature, blood

pressure and heart rate, sat alongside the couple.

Jicha asked Mr. Jones a series of questions—about his educational background, recent memory problems and how these problems are interfering with his daily life, any family history of mental or memory problems, and continence issues. Mrs. Jones answered for her husband, who said little and stared silently ahead from his wheelchair during the exam. He was then asked to draw a clock and place the correct numbers. He couldn't do this. He was asked to write his name, and this proved, also, to be beyond his ability. All of these questions and exercises are part of the National Institute on Aging's Uniform Data Set (UDS), a standard set of questions asked of every patient being screened for Alzheimer's disease.



Long Distance and Up Close

UK Telemedicine in the Vanguard of Patient Care



In addition to evaluating patients in UK's Telemedicine Clinic, Gregory Jicha sees patients in nursing homes around Lexington. "It's also important to do in-person care for patients in the community," he says.

"UK probably has the best telemedicine system network in the world. Our telemedicine clinics allow us to cover the entire state, from Pikeville to Paducah, providing services where they're needed."

—Gregory Jicha

Just a routine memory exam, something Jicha has been doing since he came to the University of Kentucky from the Mayo Clinic in 2005. But there is one major difference: the patient was nearly 100 miles away, at the St. Claire Regional Medical Center in Morehead, Kentucky.

The exam took place in a 10-foot-square room in the UK Telemedicine Clinic, where the Joneses and their nurse appeared on a TV screen, the interaction made possible by a small, PC-like box with processing power and a consumer-grade camcorder. The camcorder is essential to Jicha's visual exam of a patient, since it allows him to focus on specific parts of someone's body, the hands, for example, to check for signs of tremor.

Mr. Jones is one of 26 patients participating in a project called Telemedicine Assessment of Cognition in Rural Kentucky. Jicha is leading this study. The goal of the project, which began in the fall of 2008, is to adapt and validate the UDS and other measures for diagnosing mild cognitive impairment (MCI) and early dementia in the telemedicine setting. A related and obviously important goal is to determine whether these consultations are as effective as face-to-face meetings with a doctor.

"We know there's a lot riding on this study," says Jicha in a resonating baritone from his small, book-strewn office. When Jicha, a rangy 6 feet, 3 inches tall, stretches out from his chair, he seems to occupy this entire space. "We believe that developing and validating this telemedicine approach toward diagnosing and treating MCI and early dementia will become a model for clinician-researchers at other centers serving rural populations." He adds that UK established one of the first telemedicine programs in the country, in 1984, and has continued to be a pioneer in this approach to helping patients.

Initially he wanted to recruit 40 patients distributed evenly into three categories—those with normal cognition, with MCI, and with early dementia. But Jicha says he may not need that many patients. "We've done 26 now and have maintained the distribution we wanted. The diagnostic accuracy is so high already, statistically significant, that we may want to go ahead and publish what we've found so far." Jicha presented preliminary data from this study at the American Academy of Neurology last spring, and the reaction of those attending this



Rob Sprang, director of Kentucky Telecare since 1996, coordinates regular clinics for 25 UK physicians. "We're in the business of extending health-care resources from UK to the rest of the state," Sprang says.

session was overwhelmingly positive, he says. "I'm eager to get this out there in the literature so people can begin to adopt and replicate and implement this telemedicine approach in their local area."

But why this long-distance approach? Why not an in-person evaluation?

"This program is focused on rural or remote areas of Kentucky, where people don't have access to high-level medical care, especially sub-specialty care in the area of geriatrics, aging and memory, and thinking problems," says Jicha. "That's very important. Kentucky has several hundred thousand people who have Alzheimer's disease, but only a small percentage of these people in rural areas are evaluated, and even fewer than that are treated. This is a big problem."

Two major factors contribute to this problem. Health-care professionals in rural areas of the state are in short supply. The amenities of urban life tend to attract physicians and nurses to Louisville or Lexington, Jicha says. "Of course people can drive to these cities, but that's time-consuming and can be expensive. Plus, it's important to recognize the burden of traveling long distances with a dementia patient."

To meet the needs of people in rural areas faced with these challenges, the University of Kentucky began a telemedicine program in 1984. The Memory Disorders Clinic is one of 12 ongoing telemedicine clinics at UK;

others include cardio-thoracic gastroenterology, child psychiatry, dermatology, and surgery. "Many people don't realize it," Jicha says, "but UK probably has the best telemedicine system network in the world. Our telemedicine clinics actually allow us to cover the entire state, from Pikeville to Paducah, providing services where they're needed." The infrastructure to do this is supported by the commonwealth's annual \$20 million commitment to high-speed networking.

In addition to specialty cameras and diagnostic tools such as electronic stethoscopes, physicians in all of these clinics evaluate new and follow-up patients, and then send recommendations to the primary-care provider. A specially trained nurse attends the "video visit" with the patient and acts as the physician's "hands."

Jicha stresses that telemedicine is not only important for the immediate health of the patient, but also includes a strong educational component for doctors. "As soon as this program began, I started receiving calls from doctors who were referring patients with suspected memory problems. So I would evaluate a referred patient via teleconferencing, make a diagnosis, and send back detailed reports of the testing we had done, how we approached the situation, available treatment options, and my recommendations." Jicha recalls one doctor who, based on Jicha's report, sent a second referral and was able to accurately diagnose the patient as having mild cognitive impairment likely caused

by Lewy bodies. These accumulated bits of protein inside the nuclei of neurons in the brain control particular aspects of memory and motor control.

"This doctor's referral note was in essence as correct and in-depth as my consultation note back to him," says Jicha with a smile. "So I didn't necessarily turn this individual doctor into a behavioral neurologist, but I had provided enough information that he was able to make very detailed dementia diagnoses and establish appropriate treatment regimens. Now he no longer sends me classic, straightforward Alzheimer's disease patients. This kind of impact will change the level of medical care across the state."

Jicha adds that the project's educational component isn't focused strictly on care providers; he also wants to educate the general public about the aging process. "Unless people are educated to realize that memory and thinking problems are *not* part of the normal aging process, that they represent instead a disease of the brain and that there are treatments that can help, we will continue to see patients in a first evaluation who are almost mute and incontinent and in the end stages of disease. I've seen this way too often. I'll ask the family, 'Why did you wait so long?' They usually say, 'We didn't realize there was a problem.' To which I say, 'C'mon.'"

To educate the general public about aging, Jicha is taking several approaches. Volunteers from Sanders-Brown and the Kentucky Alzheimer's Association are running telemedicine clinics for groups of Alzheimer's caregivers in 14 Kentucky counties. One recent program focused on end-of-life issues and hospice. And to promote educational

"Our goal is to ensure that though telemedicine is not *better* than an in-person evaluation, it's *as good as* an in-person evaluation. And ours is the first study in the nation that has convincingly shown that to be true."

—Gregory Jicha

programs in Appalachia, volunteers also hold live sessions focused on aging. The Alzheimer's Association put a small ad in a local newspaper announcing an event, and the attendance at that site jumped from 12 to almost 50 people in the audience that evening. "And of course there is some word-of-mouth in these rural areas about our telemedicine clinics, which always helps," Jicha says.

The Limitations of Telemedicine

Jicha is obviously a cheerleader for telemedicine, but aren't there limitations to this form of doctor-patient interaction? What about the built-in problem of the impersonal technology? Patient confidentiality? The fact that relatively few people even know telemedicine is a possibility for them?

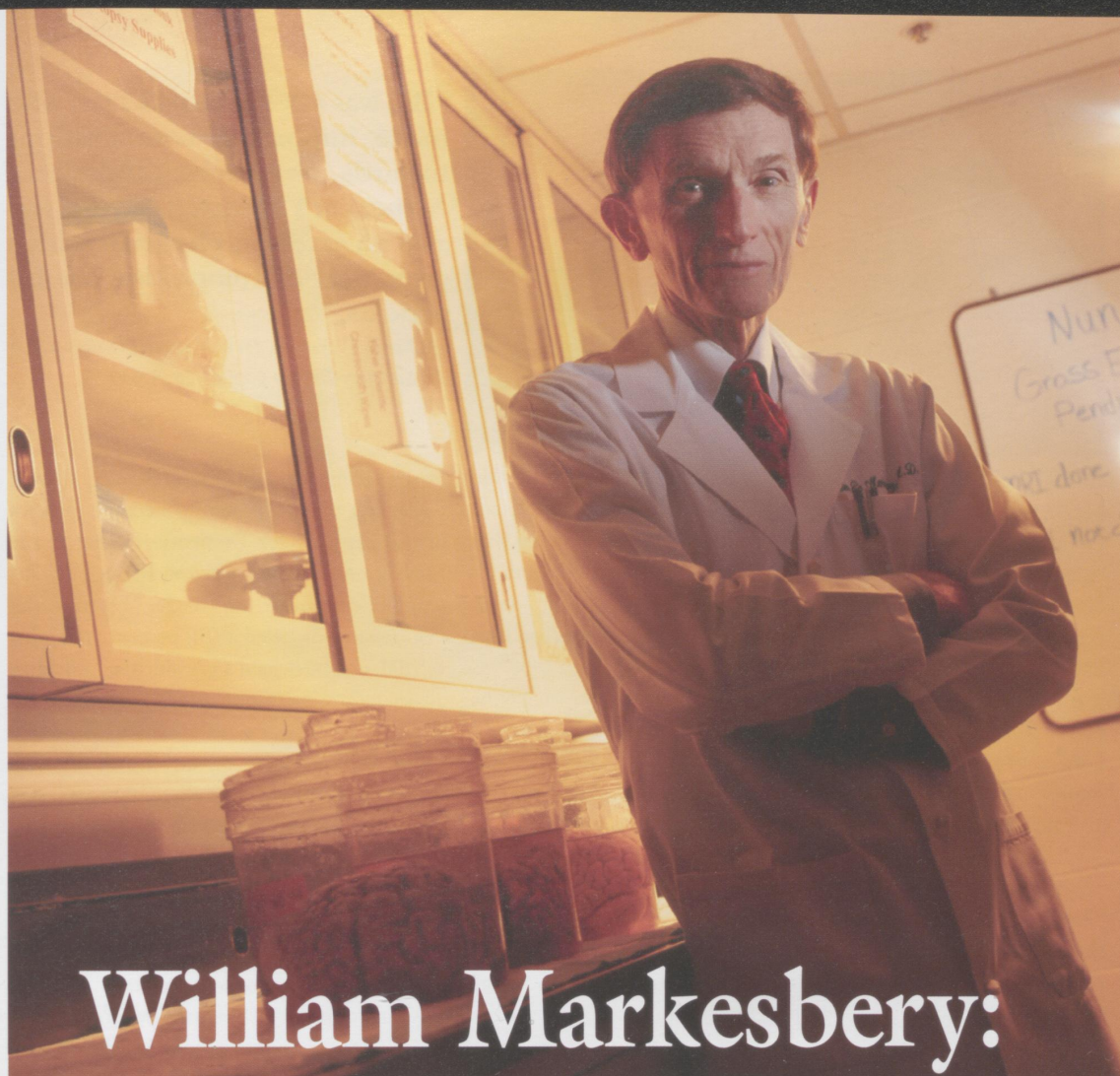
"Of course the technology itself is impersonal, but what's important is the doctor-patient relationship. Sometimes in a face-to-face exam—we've probably all experienced this—a physician can be a cold fish. There's just no rapport. So in any kind of medical examination, the level of rapport depends on the personality and training of the physician," Jicha says emphatically. He adds that, on the contrary, some patients feel more comfortable, or secure, because of the distance.

Confidentiality is an issue, Jicha admits, underscoring the importance of having a secure, protected system. "But this is not an issue for us. We have a dedicated line with secure access to the various clinical facilities. Every patient is totally protected."

But what good is this technology if only a few patients use it?

Jicha laughs. "Well, we're working on that one. And you have to keep in mind that as far as the Memory Disorders Clinic's telemedicine examinations, we've only been doing this for three years. We started out in Morehead and Hazard, and now reach out to 15 facilities around the state.

"The bottom line is, our goal is to ensure that though telemedicine is not *better* than an in-person evaluation, it's *as good as* an in-person evaluation. And ours is the first study in the nation that has convincingly shown that to be true." ■



William Markesbery:

A legacy of distinguished work and great compassion

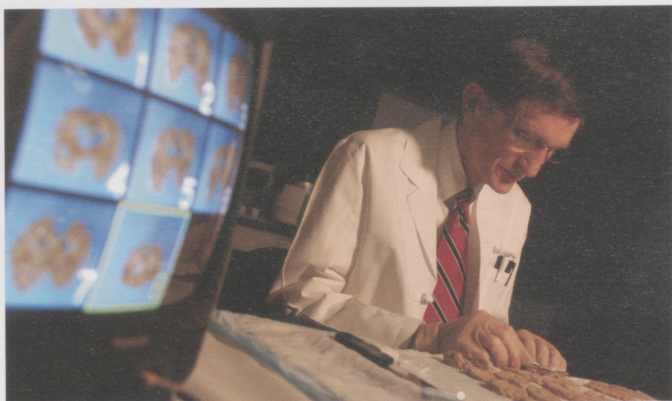
By Jeff Worley

To say that William Markesbery was an extraordinary man would be an understatement. When he died last January at the age of 77, Markesbery left a rich legacy as a world-class researcher, clinician and administrator.

In his work, he was dedicated to nothing less than finding a cure for Alzheimer's disease. Over the years, Markesbery received more NIH grants than any other researcher at UK, and his studies involving Alzheimer's disease received continuous NIH support for almost 30 years. Markesbery is credited with more than 400 peer-reviewed scientific publications, and he received numerous awards recognizing his work to better understand and prevent Alzheimer's.

Markesbery graduated with distinction from the UK College of Medicine in 1964. After working at a neurological institute in New York and taking a faculty position at the University of Rochester School of Medicine, he returned to UK in 1972 to begin his longtime career as a researcher and clinician. In 1974, he was the first to describe a rare form of heredity muscular dystrophy, now called Finnish-Markesbery Disease.

In 1981, he led a research team that published the first of several studies to disprove the once-popular theory that an accumulation of toxic metals, such as aluminum, plays a role in the development of



"Bill was a dedicated scientist who made important contributions towards our understanding of Alzheimer's disease, and he was also an excellent physician with a great deal of compassion for his patients."

—David Wekstein, former associate director of the Sanders-Brown Center on Aging

Alzheimer's disease. Later, this group proved there was no connection between mercury and Alzheimer's. In 1991, Markesbery and collaborators published the first of several pioneering studies proving that oxidative stress is an important part of the pathogenesis of Alzheimer's disease and is present early in the disease. Oxidative stress occurs when cells over-produce oxygen, which causes the release of free radicals and results in cellular degeneration.

Awards for his research followed almost routinely over the years, and in 2009 the *Journal of Alzheimer's Disease* ranked Markesbery 23rd among the top researchers in the world for the productivity and impact of their scientific study of Alzheimer's disease. That year he also received the National Alzheimer's Association Khachaturian Award for Outstanding Achievements in Advancing Alzheimer's Science, an honor of which Markesbery was especially proud. "Nothing is quite as rewarding as the recognition of one's peers," he said. "I am grateful to have the opportunity to take part in the investigation of the most devastating disease that affects humanity. It has been a privilege to care for individuals with the disease, support the families and, through research, strive to gain a better understanding of Alzheimer's disease so that one day soon we will learn how to prevent it in those at risk and stop its progression."

In a 2007 interview, Markesbery talked about what potential victims could do to fight Alzheimer's disease: "Exercise is important, as is a low-fat diet. Use your mind by participating in book clubs, working with computers, and doing crossword puzzles or other intellectual activities. Exercise your brain."

When the UK Sanders-Brown Center on Aging opened in 1979, Markesbery was named director of its Alzheimer's Disease Center. One of 10 original NIH-funded Alzheimer's Disease Research Centers, Sanders-Brown from its inception has been dedicated to advancing the well-being of the elderly. "Our major goal is to support healthy aging," Markesbery said. "Sanders-Brown is at the forefront of research on prevention and early diagnosis of dementing diseases and studies on the causes of those diseases, and considerable research efforts are also directed at understanding normal brain aging."

At Sanders-Brown, Markesbery also became a mentor to a younger generation of scientists working to solve the Alzheimer's puzzle.

"I began as a postdoc with Bill, and during that time he quickly became a role model as a researcher and teacher," says Jeffrey Keller, who worked at the center for eight years, becoming an associate pro-

fessor and assistant director of Sanders-Brown. Keller left two years ago to become director of the Institute for Dementia Research and Prevention at the Pennington Biomedical Research Center in Baton Rouge. "I started this institute and modeled it 100 percent after what Bill did, and he helped a great deal in providing advice for setting things up, and monitoring our progress."

"I had the pleasure of working closely with Bill Markesbery for more than 30 years," says former associate director of Sanders-Brown David Wekstein. "Bill was a dedicated scientist who made many important contributions towards our understanding of Alzheimer's disease, and he was also an excellent physician with a great deal of compassion for his patients."

Allan Butterfield, a UK professor of chemistry and director of the Center for Membrane Sciences, echoes this sentiment. "I worked alongside Bill on several Alzheimer's-focused projects over the years at UK and saw firsthand what a talented and distinguished researcher he was. And he was also an outstanding clinician. Bill was named one of the top 50 physicians in the United States, an achievement consistent with his manner of treating patients and their families with compassion, respect and dignity."

"Dr. Bill Markesbery left an indelible mark not only on the University of Kentucky, but also across the globe as one of the top Alzheimer's researchers in the world," says UK President Lee T. Todd, Jr. "There is no doubt that Bill Markesbery's work will live on for generations to come as we continue the work he started here almost four decades ago." ■

Odyssey
Spring 2010

Parting Shots

If we don't change
direction soon, we'll
end up where we're
going.

—Irwin Corey

I wanted change and excitement and
to shoot off in all directions myself,
like the colored arrows from a Fourth
of July rocket.

—Sylvia Plath

**Change is
inevitable—
except from
a vending
machine.**

—Robert C. Gallagher

**Change is the constant, the signal
for rebirth, the egg of the phoenix.**

—Christina Baldwin

**Change
is the
process
by which
the future
invades
our lives.**

—Alvin Toffler

I get up every morning
determined to both
change the world and
have one hell of a good
time. Sometimes this
makes planning my
day difficult.

—E. B. White

**Science
arose from
poetry—
when times
change the
two can
meet again
on a high-
er level as
friends.**

—Johann
Wolfgang
von Goethe

**We did not change
as we grew older;
we just became
more clearly
ourselves.**

—Lynn Hall

**Strike another match,
go start anew.**

—Bob Dylan

**There is nothing like returning to
a place that remains unchanged
to find the ways in which you
yourself have altered.**

—Nelson Mandela

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