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Listening in on the Brain

New Technologies to Fight Neurological Disorders

University of Kentucky Research and Graduate Education

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The cover features details of Greg Gerhardt's ceramic sensors, which allow him to measure dopamine levels in the brain in real time. This new technology is setting the stage for better treatment of neurological disorders like Parkinson's disease. The actual length of the sensor is 2.4 inches. For more, see "Listening in on the Brain" on page 2.

F E A T U R E S

LISTENING IN ON THE BRAIN 2

TECHNOLOGY WITH THE HUMAN TOUCH 8

FLEXIBLE THINKING KEY TO BEING GOOD AT MATH 14

BREAKING INTO THE EARTH'S WATER VAULT 16

UK LAW PROFESSOR RECOGNIZED FOR CLASS-ACTION EXPERTISE 20

TARGETING WOMEN'S HEALTH 22



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copy 1

DEPARTMENTS

UK RESEARCH FOR THE FUTURE 26

GRADUATE EDUCATION

MARTIN SCHOOL'S HAIST WINS NATIONAL AWARD 28

A NEW UK VOICE ON THE "SCIENCE OF CHOICE" 29

KIOSK

REID IS NEW APPALACHIAN CENTER DIRECTOR 31

NEW NETWORKING ALLIANCE
AT HARDYMON BUILDING 32

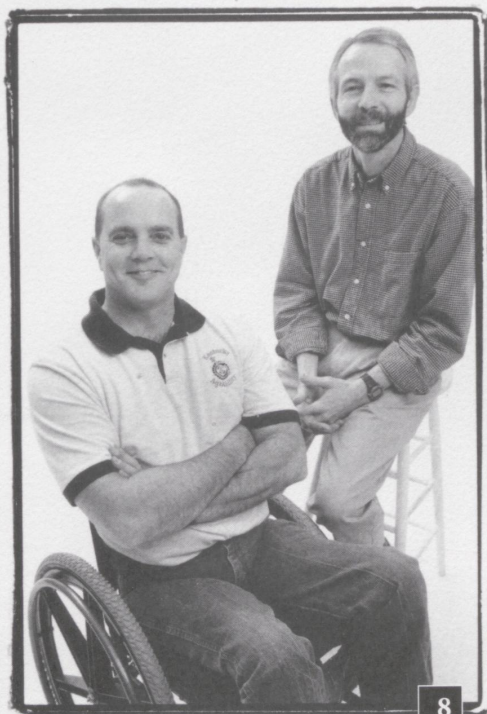
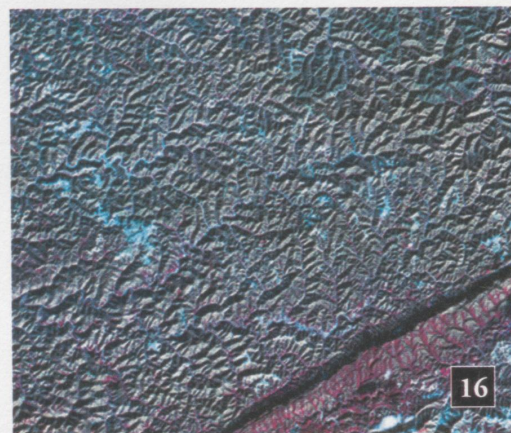
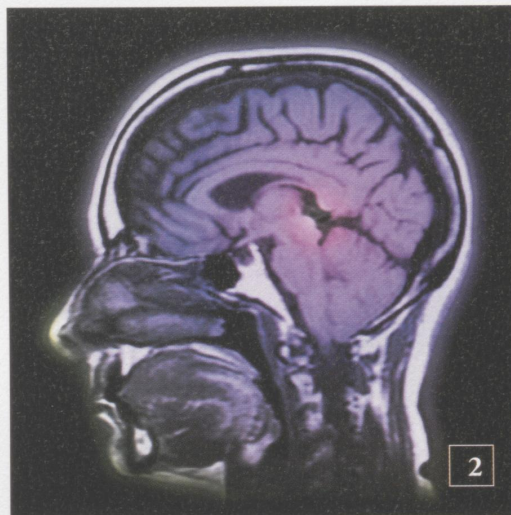
ADHD AND STORYTELLING 33

THE PIGEON WORK ETHIC 34

MONARCH BUTTERFLIES IN THE NEWS 35

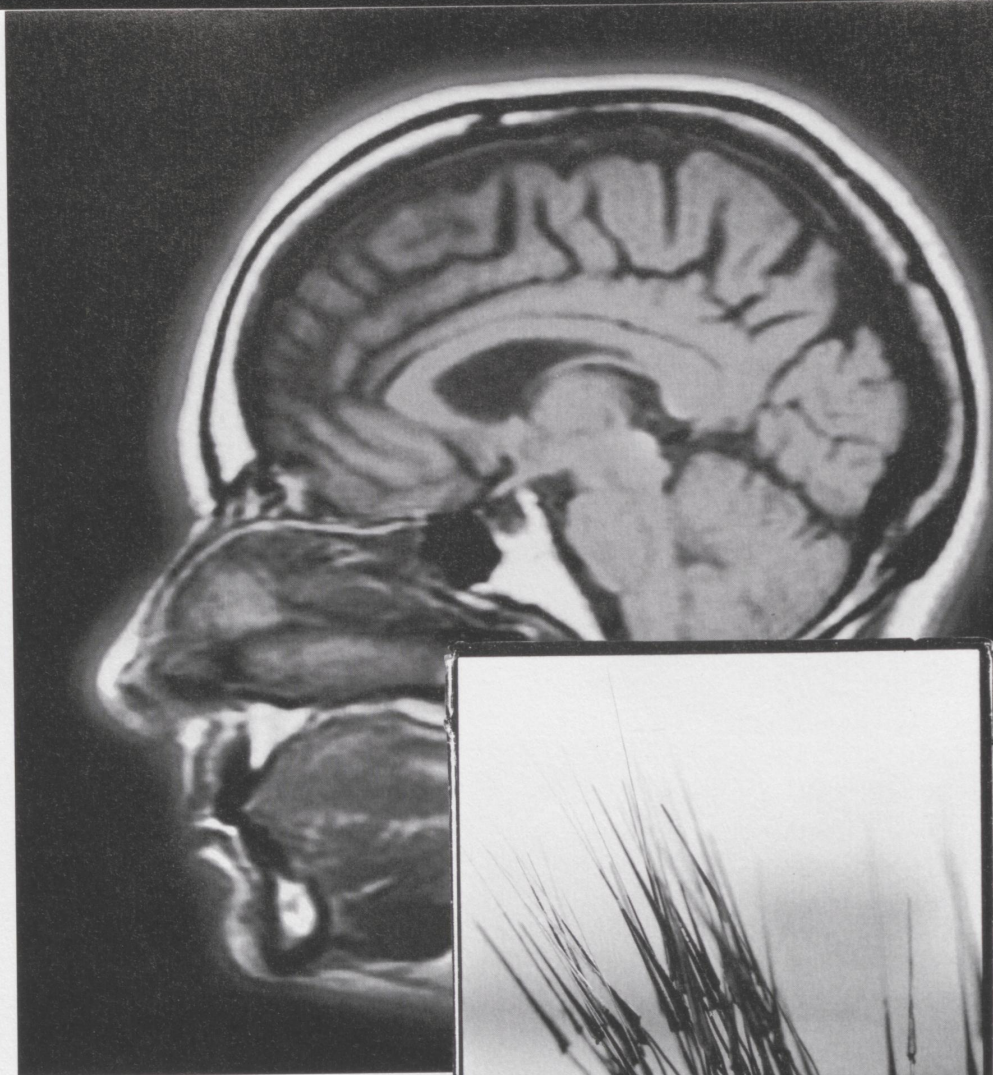
DETECTING PCBs 35

OPTIMISM A STRONG ALLY FOR IMMUNE SYSTEM 36



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Can the technology that created the microchip help to restore motor function to people with Parkinson's disease? Greg Gerhardt at the University of Kentucky thinks so, and he's designing high-tech microsensors and electrodes that may one day allow doctors to deliver powerful proteins directly to the brain to treat people with devastating neurological disorders.

Though today's most advanced microchips bear only a vague resemblance to the mysterious circuitry inside our heads, Gerhardt is using this technology to eavesdrop on the brain's most vital communications. Microchips are created with photolithography, a process in which photosensitive film is exposed to ultraviolet light to produce a pattern on a thin wafer. "Our newest sensors are patterned with photolithography onto small ceramic wafers, cut out with lasers, and



Listening in on the Brain

New Technologies to Fight Neurological Disorders

WRITTEN BY
ALICIA P. GREGORY

Gerhardt is using microensors and electrodes to eavesdrop on the brain's most vital communications.

microbonded to a microelectrode holder," says Gerhardt, who came to UK in 1999 and is director of the Center for Sensor Technology.

"Biology is chemical communication, and if you want to understand biology you have to understand chemical communication between cells. These sensors can give us new insights into how the nervous system works. We can count the number of molecules on the surface of the sensor very rapidly and what that allows us to do is literally listen as brain cells communicate with each other," says Gerhardt, a professor in the UK College of Medicine Department of Anatomy and Neurobiology.

The sensors are very tiny, about half the thickness of a human hair. (A human hair is approximately 0.003 inches or 75 microns.) These microelectrodes can be implanted in various regions of the brain to measure neurotransmitters—molecules involved in brain signaling—which include dopamine, norepinephrine, serotonin, glutamate, and nitric oxide. Previous studies in animals have revealed that disruption of dopamine regulation in the brain is the primary cause of the movement problems associated with drug-induced Parkinson's disease.

For his study of Parkinson's, Gerhardt has designed sensors with a thin polymer coating that attract dopamine molecules. "The polymer is negatively charged so it

UK's Sensor Center

Gerhardt founded the Center for Sensor Technology nine years ago at the University of Colorado, where he held a position as a professor of psychiatry and pharmacology. "My research group has always focused on the development of technologies to study the living brain," Gerhardt says. "Because of our extensive collaborations throughout the world, in 1991 the National Science Foundation funded our work and basically mandated that we formalize as a center."

What Gerhardt created is now called a "virtual center," or what NSF calls a "center without walls." He explains that his "center without walls" includes an administrative office, now at UK, and investigators here who are developing new sensors, but also encompasses more than 100 affiliated research groups at universities and companies around the world. "In the era of e-mail, this works very well," Gerhardt says. "Right now I have a number of collaborations going on with scientists in Holland, Sweden, Germany, Taiwan, and all over the United States and Canada, and the beauty of this arrangement is that we're all working on similar technologies, but we're all supported by our individual institutions."

In 1995, Gerhardt created Quanteon LLC, a private company established to handle the marketing and sales of products developed by the Center for Sensor Technology. "We developed Quanteon, quite frankly, because we realized we were developing technologies other people wanted to buy. It's very valuable to have this company because the center focuses on the development and use of new technologies, while the emphasis on manufacturing and selling these technologies can be handled by a separate entity."

Quanteon operates on what Gerhardt describes as an Asian model of small business. "We farm out a lot of our technology assembly. One of the reasons I came to UK was the availability of small companies in the Lexington area that were willing to work with us on the development of scientific products. One in particular is PCB Assembly Inc. in Lexington. They've been absolutely invaluable to us," he says. "This company understands that you can't think about making scientific technology as you would manufacturing toasters—you're going to make a technology that not everybody in the world is going to be interested in. It is highly specialized."

Gerhardt says Quanteon currently doesn't have any products that fall under the "general market" category; Quanteon's technologies are in demand only by government and industry laboratories, and universities. But his teams are currently working on prototypes of instruments for surgeons. "In fact, we are working with Harvard University on a procedure to actually use the sensors during neurosurgery as a tool to better monitor what's going on in the brain."

Quanteon has manufacturers and distributors all over the United States, and recently made an alliance with a company in Stockholm to build and distribute Quanteon's instruments in Europe.

In September of 1999, Gerhardt transferred his research laboratory, including more than \$4 million in funding, and research projects and technologies associated with the Center for Sensor Technology, to UK. Quanteon relocated to Nicholasville, Kentucky, just south of Lexington.

continued on page 4



GREG GERHARDT, WHO CAME TO UK IN 1999 FROM THE UNIVERSITY OF COLORADO, IS DIRECTOR OF THE CENTER FOR SENSOR TECHNOLOGY.

In creating these sensors, Gerhardt tapped into a whole field of science focused on identifying "biocompatible materials," materials that won't set off inflammatory responses in human tissue.

attracts positively charged molecules," he explains. "When dopamine touches the electrode's surface by going through that nanometer-thick polymer film, the sensor makes the molecule oxidize, or lose electrons; then the sensor counts the electrons from the oxidation." The number of electrons directly relates to the number of the molecules present. This electrochemical process happens very rapidly, Gerhardt says. Just as quickly as it is oxidized, the sensor gives back electrons to the molecule.

"The sensor counts only the molecules that touch it, a fact that gives us tremendous capability to map how brain circuitry works," he says.

Gerhardt's research team has already tested these sensors by "listening in" on brain activity in animals with drug-induced Parkinson's disease. Implanted sensors allow researchers to monitor what is going on in the animals' brains while they are in motion and at rest. "We've discovered that these procedures are relatively non-invasive, because they cause minimal damage to brain tissue, and they're safe," he says. In creating these sensors, Gerhardt explains,

he's tapped into a whole field of science focused on identifying "biocompatible materials," materials that won't set off inflammatory responses in human tissue.

Gerhardt's sensors involve microcabling and small devices called headstages that process the information from the sensors very close to the source. Headstages range in size from a few centimeters to about the size of a deck of cards and are composed of a small computer chip and a cable connection. These devices do the initial signal transformation; they convert data from the sensor into electronic signals the computer can process. (Gerhardt points out that with modern electronics it's possible to do all the data processing on the sensor itself, but right now that's too expensive.)

Measurements that once required a multitude of scientific instruments are now all handled in one computer software program. "You literally just push a button and the computer takes over," Gerhardt says. "One of our latest technologies is going to be marketed in the \$12,000 range. It includes an integrated system that plugs into a modern Pentium computer and all the

necessary hardware and software to carry out the measurements from these microsensors."

Gerhardt's first sensors cost him \$10,000 each. "But now we've already dropped that cost to about \$100, and I expect the cost will decrease to more like \$25 a piece once we start to mass-produce them," he says.

"We need to educate people that this is a device that is best used and then thrown away—a fact which should make it very popular in the United States," Gerhardt says, slightly tongue-in-cheek. "It's disposable."

"After a while white blood cells, red blood cells, and proteins stick to the surface of the sensor and interfere with the signaling process," he explains. "There's an enormous amount of science going on right now looking at modifying surfaces so that they're less prone to 'foul.' Essentially what we're talking about is poisoning—the biology poisons the electrode." Gerhardt says in the first few hours after a sensor is implanted it loses about 10 to 20 percent of its sensitivity because of rapid adsorption of certain brain proteins. "The polymer coating we use has extended the lifespan of our sensors. We can record in the brain for weeks, perhaps even

months, but in the future we'd like to record in animals and humans for years."

Interest in improved polymer coatings reaches far beyond scientists working on brain signaling, Gerhardt says. Right now researchers are working on coatings for cars that would mean the death of the car wash. Imagine a coating that would prevent dirt from sticking to the surface. Imagine the popularity of a car that washes itself in the rain, Gerhardt says. "If we get to a point where we don't have leaves and dirt sticking to our cars, surely we can put some of that technology to use in tissue or our bloodstream."

Drug Delivery to the Brain

Parkinson's, a disease that affects more than a million people in North America, progressively impairs control of body movement and often leads to immobility. Although current treatments with oral medications can almost completely restore normal movement to people in the early stages of Parkinson's, the drugs lose effectiveness as the disease progresses.

"If we could treat the disease throughout the lifespan of the individual as well as it's treated in the first three years with these medications, we quite frankly wouldn't need to be doing this research," Gerhardt says. But medications have side effects, and not all patients respond to the drugs. "We can currently treat the disease, but that doesn't mean the person's life is like it was before they developed Parkinson's." He says quality of life, after all, should be the ultimate concern.

Improving the quality of life for people with Parkinson's disease has been a career-long goal for Don Gash, chair of UK's anatomy and neurobiology department. He has studied Parkinson's in animal models since 1985.

"In the mid-'80s, researchers were trying to leap directly from rodent studies to humans," says Gash. "A human brain is approximately 1,300 grams; a rat's brain is about one gram. We need to know how to translate rat data to the larger human brain

context. This scaling up is critical as you're trying to work out new therapies," he says.

Gash and Gerhardt have known each other for nearly 20 years, but it wasn't until 1991 when Gash was working at the University of Rochester and Gerhardt was at the University of Colorado that they officially began to collaborate. When Gash joined the UK faculty in 1993, Gerhardt began traveling to Kentucky to continue their work, and in 1995 Gerhardt became a visiting scientist in the anatomy and neurobiology department.

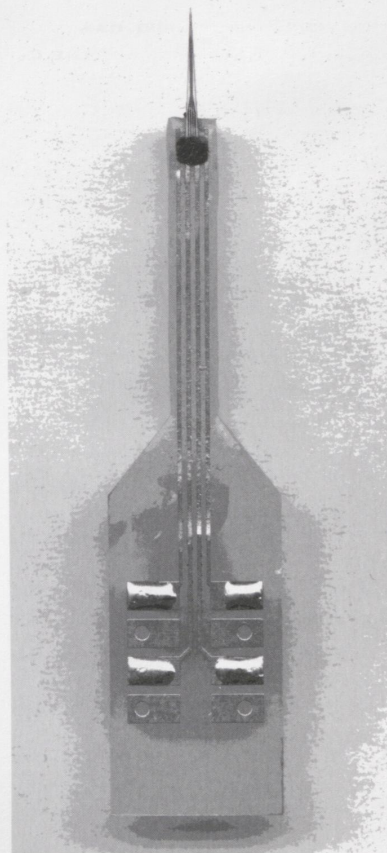
Gerhardt was recruited to UK under the initial phase of the Research Challenge Trust Fund (RCTF) program established by the 1997 Kentucky Postsecondary Education Act. This phase of RCTF included \$16 million to support new faculty, graduate students and staff. "The Research Challenge Trust Fund allowed us to put together the resources to enable Greg to do research here that would be hard to do elsewhere," Gash says, attributing UK's MRI (magnetic resonance imaging) and animal research capabilities as strong lures. Gerhardt says the RCTF program provided exactly what he needed—a faculty position, start-up funding, and good research space.

In 1999 Gash and Gerhardt's collaboration led to a five-year, \$5 million grant from the National Institute of Neurological Disorders and Stroke (NINDS), part of the National Institutes of Health. The NINDS grant established a Morris K. Udall Parkinson's Disease Research Center of Excellence at UK, one of only eight centers funded that year.

The grant supports a collaborative project by Gerhardt, Gash and Zhiming Zhang that will lay the foundation for a new therapy for Parkinson's disease—direct delivery of a key protein to the brain to repair damaged cells. This research is focused on a protein called glial cell-line derived neurotrophic factor (GDNF). "Trophic factors are proteins manufactured by cells, often used in cell programming, differentiation, growth,

continued on page 6

"We need to educate people that this is a device that is best used and then thrown away—a fact which should make it very popular in the United States," Gerhardt says, slightly tongue-in-cheek. "It's disposable."



and maintenance," Gerhardt explains. "Perhaps the most widely studied is Nerve Growth Factor or NGF. Lack of that protein seems to play a fundamental role in Alzheimer's disease."

GDNF is found in low levels in the adult human brain and may allow these researchers to "turn back the clock" on dopamine neurons sabotaged by Parkinson's. "If we re-administer this protein in an adult brain that's damaged, it looks like we can potentially arrest further degeneration and even repair some of those neurons," says Gerhardt.

Gash attributes UK's success in attracting the NINDS grant to the team's unique combination of expertise. "It's a credit to the team. Each person brings a number of strengths into this," he says.

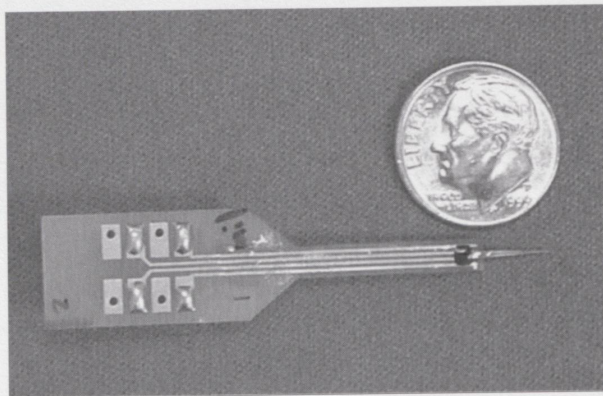
"Greg's skills in electrochemistry are unique in a lot of ways. He's viewed by his peers as a very productive and original thinker at the cutting-edge of developing sensor technology and adapting it for use in studying the brain. He blends his expertise in analytical chemistry with insights into modern questions in neurobiology, an unusual combination," says Gash.

"Greg has the capabilities to figure out what is going on in the brain using neurochemistry, and Zhiming Zhang, a neurosurgeon from China, uses MRI and is working on site-specific delivery of trophic factors—which we think is the key to using these factors to treat Parkinson's. Collectively, our team is able to do functional neuroanatomy at a level that's really not possible at many other places in the world," Gash says.

The team's research is focused on modifying the Medtronic SynchroMed® Infusion System, an implantable and programmable pump, to deliver drugs directly to the brain. Medtronic Inc., based in Minneapolis, Minnesota, is an international medical technology company known for its pacemakers. Medtronic began working with

Gerhardt and his Center for Sensor Technology at the suggestion of the National Science Foundation in 1994.

Dennis Elsberry, a technical fellow in Medtronic's drug delivery venture area who holds 16 patents, says the company finds collaboration with academic researchers advantageous. "What we try to do in selecting academic institutions is to leverage the specific research capability they have to address the questions we need to have answered with



regard to establishing the safety of delivery to the central nervous system," he says.

Elsberry's research in the 1980s led to the development of the SynchroMed pump, a device that is currently approved to deliver drugs directly to the fluid around the spinal cord in patients with chronic and intractable pain, cancer pain, and severe muscle spasticity, as well as deliver chemotherapy agents to treat colorectal cancer that has spread to the liver.

"This self-contained, computer-controlled, stainless steel pump is about the size of a hockey puck," Gerhardt says. "It works via a principle called peristalsis. It has a little motor and a wheel that pinches tubing to move fluid through a plastic line." The pump is refilled each month and has a battery that lasts for three years. "It's computer programmable with a wand, which means you can reprogram it across the skin." Drugs travel from the pump, often

implanted in the abdomen, through small tubes placed under the skin to the tiny device the UK team is designing that will allow drugs to flow into the brain.

"What we're developing are miniature tubes that can be inserted directly into the brain to administer proteins like GDNF," says Gerhardt. "This collaboration with Medtronic is laying the foundation for not only administering GDNF, but also a whole host of other drugs that can't be swallowed or injected into the bloodstream for the treatment of a variety of brain disorders."

One advantage of direct-delivery technology is that proteins will be able to bypass the blood-brain barrier. "The blood-brain barrier is not really a physical barrier," says Gerhardt. "It involves the fact that not all molecules or drugs can penetrate the brain from blood vessels." He says there's a lot scientists have yet to learn about this barrier, but it's clear that many drugs or proteins, like GDNF, can't cross it.

This technology will also eliminate potential side effects because drugs will be delivered only to the damaged neurons. Gerhardt says GDNF and similar proteins have a variety of effects on other systems within the body, which automatically rule out giving drugs orally. "For example, GDNF is involved in the normal development of your kidneys," he says. "If we made an oral drug today that activates the systems this protein normally activates, we'd probably set off so many side effects it could be catastrophic."

Gerhardt points out that the biggest challenge to this new technology is fear. "Most people don't want to have us stick a tube in their brain. But the reality is that the medical community has very successfully been putting tubes in the human brain for about 80 years. While it sounds a little like something out of Star Trek, the insertion of tubes—most clinicians refer to them as shunts—is actually a very safe procedure," Gerhardt says.

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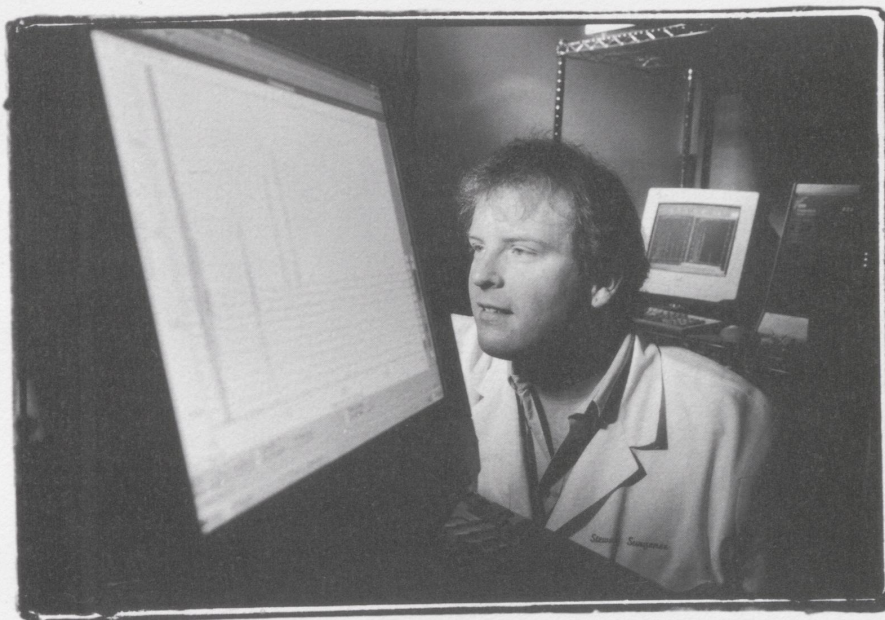
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The team's research is focused on modifying the Medtronic SynchroMed® Infusion System, an implantable and programmable pump, to deliver drugs directly to the brain.



STEWART SURGENER, A UK GRAD AND RESEARCH ANALYST IN GERHARDT'S LABORATORY, USES HPLC (HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY) TO STUDY NEUROTRANSMITTERS IN BRAIN SAMPLES.

"I've talked to patients with Parkinson's, and this concept doesn't seem to bother them, because, after all, they're living with the disease. It's the family members of the patients who say, 'You're going to put a tube in his brain? Can't you do something else?' So we'll have to educate people that if there were any other way to do this, we certainly would. This is the safest method to deliver these very powerful proteins."

This research is currently in the preclinical stage. "We're pushing forward to gain safety data so we can go to the FDA, and, we hope, carry out a clinical trial here in the next several years," Gerhardt says. The team is gathering that data based on the technological contributions of Amgen and Medtronic provided at no cost to UK. Amgen, an international drug company headquartered in California that makes GDNF from E-coli,

is supplying UK with the purified protein.

"Medtronic has provided us with pumps, associated technology and technical support that would have cost us hundreds of thousands of dollars. The pumps themselves used clinically are valued at \$10,000 each, and we have 20 animals with these pumps. Medtronic has given us \$200,000-plus in product, not counting the computer to program the pumps," Gerhardt says.

"Without cooperation from Medtronic and Amgen and a whole host of other companies and biotech firms, it would be another three or four years before we could even begin thinking about clinical trials," he says.

Success in adapting this direct-delivery pump may have a ripple effect on technology and medicine, says Gerhardt.

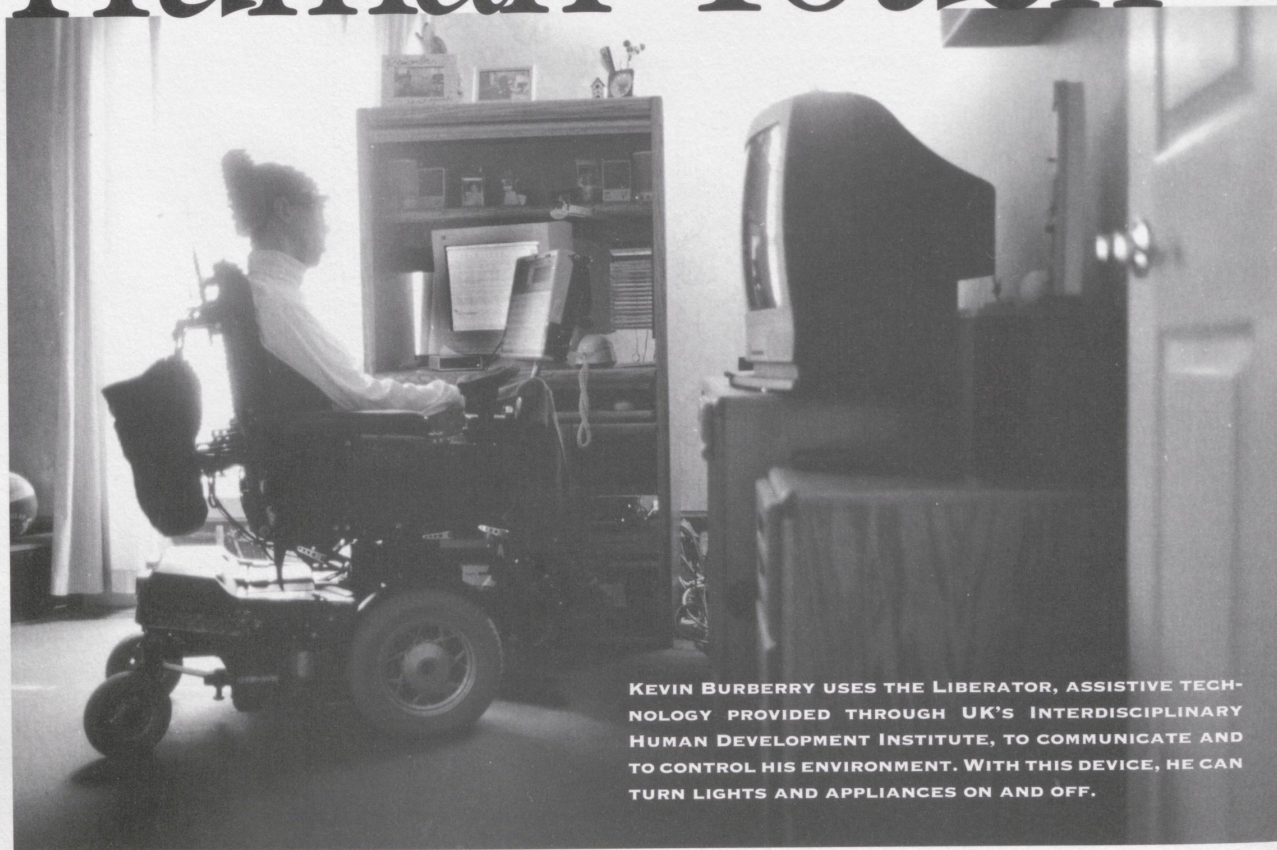
"It's not inconceivable to think of a pump that would eventually fit behind

your ear, like a hearing aid. Every day we use technology that's more complicated than this little pump, and the reason we can afford it is millions of people are buying the technology," he says. "If we can prove this technology has widespread use, we can look forward to a whole new generation of micromachines that will revolutionize the way we treat diseases." ❖

W R I T T E N B Y
J E F F W O R L E Y

Technology with the Human Touch

University of Kentucky senior Kevin Burberry sits in a motorized wheelchair in front of a specialized keyboard and watches his words crawl across the computer screen. The words, for Kevin, don't come easily or quickly. Born with cerebral palsy, a condition evidenced by speech disturbances and a lack of physical coordination, Kevin is unable to speak or to type. But thanks to some hands-on support and innovative technology provided through



KEVIN BURBERRY USES THE LIBERATOR, ASSISTIVE TECHNOLOGY PROVIDED THROUGH UK'S INTERDISCIPLINARY HUMAN DEVELOPMENT INSTITUTE, TO COMMUNICATE AND TO CONTROL HIS ENVIRONMENT. WITH THIS DEVICE, HE CAN TURN LIGHTS AND APPLIANCES ON AND OFF.

"The Liberator has removed the barriers of communication and allowed me to be known to people."

— Kevin Burberry

UK's Interdisciplinary Human Development Institute (IHDI), Kevin can communicate—and hold his own with anyone.

The technology that has enabled Kevin to unlock his voice is called, appropriately, the Liberator. "The Liberator has removed the barriers of communication and allowed me to be known to people," says Kevin, who has been attending UK for eight years. "When I received the Liberator, I started taking it to class. The result was incredible! As I began asking the questions on my own, instead of through an aide as before, the other students began to engage in open conversation with me. We even joked with each other."

His words not only appear on the screen; if Kevin wishes, he can activate a key that triggers a voice module, oddly reminiscent of the computer HAL in "2001: A Space Odyssey."

Because Kevin's head control is excellent, he operates the Liberator by use of a slender, pencil-shaped infrared light, which is attached to his glasses. The light is aligned with his line of sight. When Kevin trains the beam for a full second on one of the 10 dozen or so keys that blink brightly as a string of Christmas tree lights from the keyboard, letters, words or word clusters appear on the screen.

"I received my computer in the fall of 1993," Kevin says. "Before then, my aides had to serve as my interpreters and ask the professor questions for me. The other students knew that I had a mind, but because they did not know how to use the board to find out what I wanted

to say, they were reluctant to communicate with me."

The Liberator was purchased for Kevin with the assistance of a project headed up by Barney Fleming at IHDI. Funding came from the Kentucky State Department of Vocational Rehabilitation. Fleming says that Kevin's Liberator costs around \$9,000.

"This is what we call an 'augmentative communication device,'" says Fleming. "Its purpose is to provide expressive communication. There are a lot of people who are non-verbal or who have difficulty with speech to the degree that they need augmentative or alternative communication devices." He adds that this device can be used for more than communication. Kevin can also use it to access his computer and to control his environment—for instance, he can use it to turn lights and appliances on and off.

After Fleming mounted the Liberator onto a wheelchair attachment for Kevin, his support role shifted, he says. "Kevin and I worked together configuring and customizing the system for his communication and other needs. This device is very complex and uses a fast and efficient icon-based language called MinSpeak."

"Assistive technology expert" is only one job description that could characterize what Fleming does at IHDI. He is currently

heading up two projects that focus on

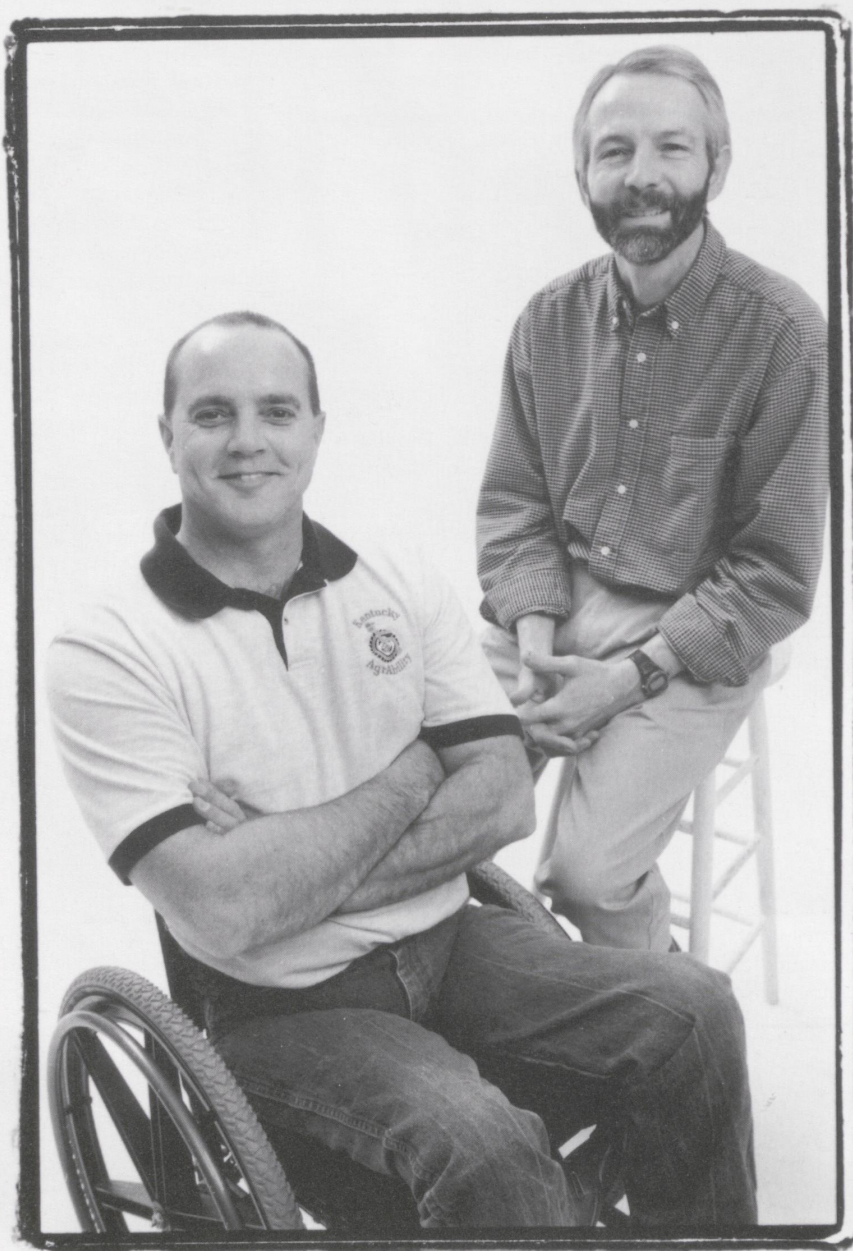
continued on page 10



CLYDE DAVID AND SUSAN BURBERRY, KEVIN'S PARENTS, HAVE BEEN HIS "PRIMARY SUPPORT SYSTEM," KEVIN SAYS.

“When I roll up to the door in my wheelchair to see farmers with disabilities, they know that whatever I have to say isn’t just from textbooks or classroom lectures.”

— John Hancock



providing rehabilitation technology services and training to people in Kentucky, and training for rehabilitation counselors and their clients. “Simply put,” he says, “my focus is to help people do something they want to do, or do better, easier or safer. Sometimes technology is the solution, sometimes it’s not. Our philosophy here is that you can do anything you want in your life; you may just have to do it a little differently. That’s what assistive technology is all about.”

Fleming came to UK in 1985 from Louisiana State University. He earned a Ph.D. in physiology and biophysics at the University of Iowa and did postdoctoral work at the Center for Bioengineering at the University of Washington. He admits, though, that he had several “shifts of interest” on the road to his doctoral work.

“I got an M.S. at Iowa in engineering and wanted to focus, initially, on engineering mechanics, but got sidetracked into biomechanics,” says Fleming. “I was working there with a hand surgeon in orthopedic surgery, and not a day went by when we didn’t see two or three people with significant agriculture-related hand injuries. So I learned a lot about prosthetics and biomechanics—the quantitative study of body motions and the forces that produce those motions.” Then after a brief time at the LSU medical center, doing research on microcirculation, Fleming joined the UK College of Medicine and was then hired as a rehabilitation engineer as part of a project in UK’s Department of Special Education.

Rehabilitation engineering, he says, perhaps over-modestly, is mostly a lot of common sense. “There are a lot of things I can’t

JOHN HANCOCK (LEFT) AND BARNEY FLEMING HAVE DONE ASSESSMENTS TOGETHER FOR YEARS, TRAVELING AROUND KENTUCKY TO BRING ASSISTIVE TECHNOLOGY AND OTHER SUPPORT TO FARMERS WITH DISABILITIES.

do. I can't do anything about a person's physical or mental impairments, but I can try to modify the environment to minimize the effects of those impairments on the person's ability to function."

For most of us, he says, technology provides convenience, efficiency and safety. But for others, it is much more. "What distinguishes assistive technology from the technology we all use every day is that we could get along without the technology; Kevin cannot. For a lot of people the technology is not an option, it's a necessity."

When Kevin leaves the University of Kentucky this spring, he will be taking with him some good memories. "I have found the quality of education at UK to be very good. I have received an excellent learning experience at this institution," he says, adding that there have been two professors who have made his time here particularly memorable.

"The first course I took at UK was taught by Dr. Henry Schankula," Kevin says. "The course material covered the philosophy stemming from the Renaissance to the modern era. Henry accepted me as a student who wanted to learn, and he worked around my physical limitations. If I needed two weeks to type a 19-page examination, he gave it to me. I also really liked Professor Dallas High, who taught the Philosophy of Religion. He has a warm and gentle spirit, and he and I have become good friends and have remained that way." [High has retired from UK and is now living in Florida.]

Leaving UK is not the only major change soon to sweep through Kevin's life.

"I'm moving to Rhode Island and getting married this summer," Kevin says, obviously elated to pass along this news. "This was an internet romance, the result of a dating service for the disabled." Kevin's parents took him to Cape Cod to meet his e-mail soul-mate, Maureen, and her family, and will drive Kevin to Smithfield, Rhode Island, where they have purchased a house in consort with the parents of the bride-to-be.

"Living with somebody else is going to be quite an adjustment," Kevin says. "However, it is an adjustment that I am more than willing to make. I'm sure I'll miss my immediate family the most when I move. I'm 32, and I have been separated from my family for only three days in my entire life," Kevin adds.

"Barney and his colleagues have been a crucial source of support for me. I can honestly say that I would not be where I am today if it were not for him," Kevin says. "Once he recognizes that a person with a disability has potential, Barney does everything that he can to bring that potential to the visible foreground."

Back on the Tractor

Fleming points out that as with all projects at IHDI, he doesn't work alone. "It is absolutely a group effort," he says. "Our director, Harold Kleinert, is involved of course in everything we do, and I'm in regular contact with rehab specialists from vocational rehabilitation, school counselors and training specialists, and UK colleagues from various departments across campus."

One of Fleming's regular partners is John Hancock, project director of AgrAbility in the College of Agriculture Cooperative Extension Service. "Barney and I have done assessments together for years," says Hancock from his office in Ag Science North. "I've known Barney as long as anyone I've known here. We troubleshoot together about once a month."

"Troubleshooting," for Hancock, means going to the aid of farmers in Kentucky who have disabilities, the goal being identical to Fleming's—to help farmers do what they want and need to do. And when Hancock shows up at a farm in Kentucky—he travels statewide in his work—his clients, he says, "make an immediate identification."

"I was in a motorcycle wreck in '84 and was paralyzed," he explains. "So when I roll

"Barney and his colleagues have been a crucial source of support for me. I can honestly say that I would not be where I am today if it were not for them."

—Kevin Burberry

up to the door in my wheelchair, they know that whatever I have to say isn't just from textbooks or classroom lectures." Hancock was attracted to this job at UK after working with disabled farmers for two years in the late '80s at Purdue University. He's always been in his element in this work, he says, having grown up on a farm in Adair County, Kentucky, where his father had a farm equipment dealership.

Hancock's primary work can be summed up in the phrase "direct service to farmers," and in the past decade at UK he has helped hundreds of farmers and farm families. With funding from the College of Agriculture and the U.S. Department of Agriculture, the AgrAbility program helps locate resources for modifications to equipment when farmers can't afford it, and Hancock assists them when they need to modify the equipment to suit their needs.

"Most farmers I've worked with are pretty good welders, pretty inventive," Hancock says. "If you can help get them started, they can usually build something that'll serve their purpose. Farmers tend to be very resourceful. Sometimes you can't buy what you need—you have to make it. We try to put our best technology in place for their

continued on page 13



SHELLEY LANE, A JUNIOR AT DUNBAR HIGH SCHOOL IN LEXINGTON WHO HAS CEREBRAL PALSY, USES THE LIBERATOR, AN INTRICATE SYSTEM OF ICONS, TO COMMUNICATE WITH THE WORLD. USING AN INFRARED LIGHT ATTACHED TO HER GLASSES, SHELLEY ACTIVATES ICONS ON THE KEYBOARD THAT MAKE WORDS AND SENTENCES. A SPEECH SYNTHESIZER, ONE OF THE BASIC FEATURES OF THIS TECHNOLOGY, ALLOWS HER TO "SPEAK." SHE IS CURRENTLY TAKING A CLASS OFF-CAMPUS TO IMPROVE HER COMPUTER SKILLS. SHELLEY'S GOAL, AFTER FINISHING HIGH SCHOOL, IS TO WORK IN THE COMPUTER FIELD, PERHAPS AS A WEB PAGE DESIGNER. IHD!'S BARNEY FLEMING PROVIDES KNOWLEDGE AND TECHNICAL SUPPORT TO DUNBAR STAFF WHO WORK WITH SHELLEY.

particular situation."

Hancock recently traveled to Garrard County after being contacted by the parents of a 14-year-old boy, Josh Land, who had been paralyzed in an automobile accident. John and Beverly Land had heard about Hancock through the staff at Cardinal Hill Rehabilitation Hospital during Josh's recuperation. Josh grew up with farming and, despite his disability, wanted to continue to help out on the family farm. Hancock's challenge: What could he do to help Josh use the tractor and operate it efficiently and safely?

"Josh had several things going for him," Hancock says. "He had a determination that he was going to do this—a feisty spirit. It also helped that his cousins had a machine shop." Hancock took the lift off one of his old tractors and gave it to Josh. Hancock, Josh and his cousins then took it into the shop and went to work on it.

"We rigged up a kind of swivel-sling-lift where Josh can sit and be lifted onto the seat of the tractor, and back down again," Hancock explains. "His cousin used a metal rod to connect the clutch and brakes to a hand lever, and since Josh still has full use of his arms, he can operate the tractor just fine."

"This works really well for me," says Josh from the Garrard County farm. "It's really easy to get in and out of."

Josh, now in Garrard County Middle School, plans to go to college after high-school graduation, then return to farming. "I just love it," he says. "For me, it's never been anything I think of as work. Whatever else I do in life, I want to farm at least part-time."

Hancock says that his biggest challenge isn't finding the right technology that can help a disabled farmer or even rigging up equipment to do the job. "The toughest thing is when you know you can't help somebody simply because the funding's not there. With the level of technology today, there aren't many things you can't do if you have the money to purchase what you need." ■

"Simply put, my focus is to help people do something they want to do, or do better, easier or safer. Our philosophy at IHDI is that you can do anything you want in your life; you may just have to do it a little differently. That's what assistive technology is all about."

—Barney Fleming

Founded in 1969, UK's Interdisciplinary Human Development Institute (IHDI) focuses its efforts on establishing environments that help people with disabilities, according to IHDI director Harold Kleinert. "By incorporating diverse activities such as research, interdisciplinary training, model program demonstration, advocacy and technical assistance, IHDI is working to promote independence, productivity and integration of persons with disabilities," Kleinert says.

Supported by nearly \$5.5 million a year, IHDI currently houses over 30 projects, loosely grouped into categories that include early childhood, inclusive education, community living, and personnel training. "People with disabilities, their families, and agency personnel join IHDI staff members to form a close-knit network of individuals sharing a vision in which all Kentuckians, including Kentuckians with disabilities, participate fully in their communities," Kleinert says.

Several IHDI projects also have a national impact. For example, IHDI staff are currently providing assistance to approximately 20 states across the nation to help implement special education programs for children and young people with disabilities.

Solve this problem. You have three minutes:

One train leaves Seattle for New York City at 9:15 a.m. and will travel at an average speed of 53 miles per hour. A second train leaves New York City for Seattle at noon and will travel at an average speed of 61 miles per hour. At what time and near what town in the Midwest will these two trains pass?

Welcome to the arithmophobe's worst nightmare.

Some students would rather leap from a train going 61 miles an hour than try to solve this problem. Other students feel an anticipatory joy in the challenge and can't wait to set to work on it.

Lillie Crowley, a mathematics professor at UK's Lexington Community College, has focused her research for the past several years on trying to understand why some students have so much difficulty with math while others find math as easy as one, two, three.

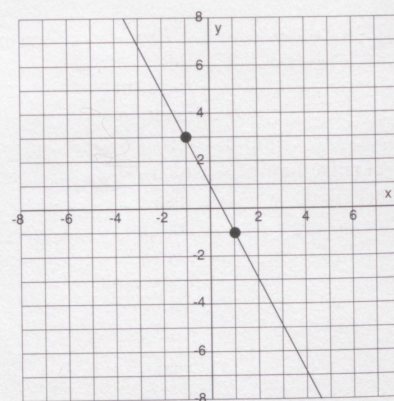
"I'm focusing my dissertation work on how students approach problems in two UK courses—intermediate algebra and college algebra," says Crowley, who has been exploring this question as part of her Ph.D. work at the University of Warwick in Coventry, England. The question is at the heart of her Ph.D. dissertation, titled "Cognitive Structures and College Algebra." She has taught math courses at the university level for 25 years.

"What's struck me over the years is how often a student will do well in intermediate

algebra (Math 108)—will get an A or a B—then go on to the college algebra course (Math 109) and crash and burn." The good grade in Math 108 should indicate a strong foundation for these students, but many fail when they move up to Math 109, a university math requirement for all degrees. Other successful 108 students continue to do well.

Crowley's thesis is that some students—those who succeed in Math 109—are able to do so because they have established tightly linked networks of "cognitive units." This term, first used by mathematician Tony Barnard in 1997, refers to a specific structure someone can use to focus on a mathematical problem. "The tools you use to solve problems are cognitive units," Crowley explains—"a formula, a graph, a set of one or more procedures—whatever you use to focus on a problem. The more successful student, the one who is ready to move on, is able to create a network of cognitive units, which becomes another, more sophisticated cognitive unit. He or she is then able to move flexibly from one solution strategy to another, usually using the one that is the easiest and least prone to error."

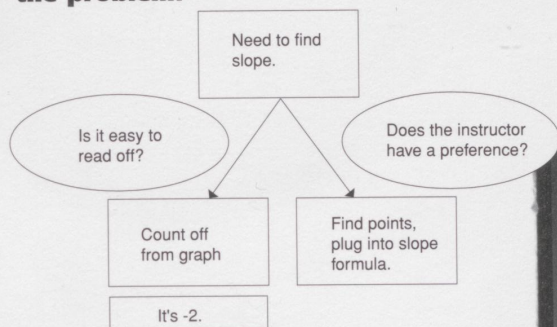
To illustrate how this concept is put into practice, Crowley cites the following problem, with commentary (below), which she assigns her students in Math 109:



"Natasha had little difficulty in pre-calculus, while Kirsten found it very difficult. The two demonstrated significantly different cognitive structure when they were asked to work the same problems. I asked them to find the slope of the line from the graph of x, y coordinates":

Flexible Thinking Key to Being Good at Math

Here is how Natasha solved the problem:

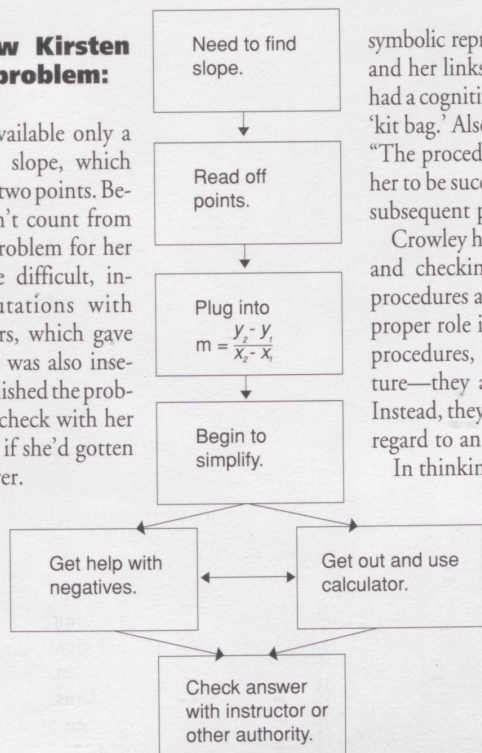


"Natasha was able to solve this problem in a few seconds by simply looking at the graph and counting squares (1, -1) (-1, 3)," Crowley explains, "which is the quickest way to the solution. She could have also solved the problem by using the formula for the slope, but this would have taken more time. Natasha had flexibility, which saved her a lot of effort on this particular problem." Crowley adds that Natasha didn't ask her whether or not she was right: Natasha was confident that -2 was the answer.

Here is how Kirsten solved the problem:

Kirsten had available only a formula for the slope, which required finding two points. Because she couldn't count from the graph, the problem for her was much more difficult, involving computations with negative numbers, which gave her trouble. She was also insecure when she finished the problem; she had to check with her instructor to see if she'd gotten the correct answer.

"Natasha demonstrated links between graphical and

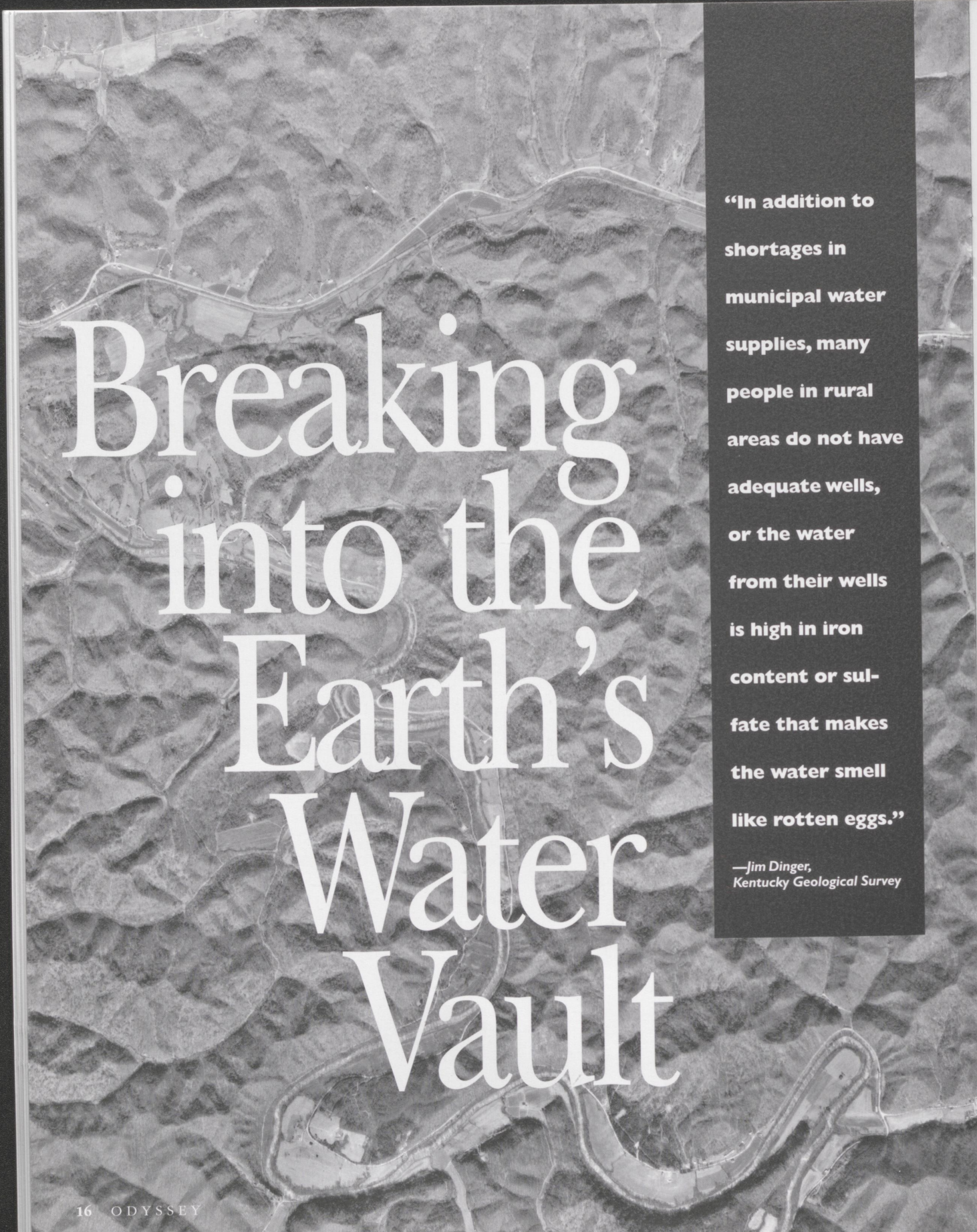


LILLIE CROWLEY IS FOCUSING HER DISSERTATION WORK ON HOW STUDENTS APPROACH PROBLEMS IN TWO UK COURSES—INTERMEDIATE ALGEBRA AND COLLEGE ALGEBRA.

symbolic representations," Crowley explains. "Her cognitive structure was flexible, and her links were adequate to lead her to the answer. Kirsten, on the other hand, had a cognitive structure that consisted of only one approach she could pull from her 'kit bag.' Also, Kirsten had difficulties with negatives and fractions," Crowley adds. "The procedures in her kit bag, combined with diligence and persistence, allowed her to be successful in intermediate algebra, but she was woefully unprepared for the subsequent pre-calculus course—Math 109."

Crowley has found through her research that when links to alternative procedures and checking mechanisms are not present, the student must resort to using procedures and strategies that have worked in the past, without a real sense of their proper role in or relevance to the problem at hand. "What is relevant is that these procedures, formulas, and tools are not part of a well-developed cognitive structure—they are not aspects of a cognitive unit to be called upon when needed. Instead, they are related, but almost random, procedures or tools to be tried, without regard to an overall plan or strategy toward a solution."

In thinking about the overall problem of "math anxiety," which Crowley admits does affect many students, she says it may help to think of mathematics merely as problem-solving. "Think of it as fun—as a game. Of course you have to have rules and procedures to do math, but this isn't what mathematics is about. It's about solving problems." ■



Breaking into the Earth's Water Vault

"In addition to shortages in municipal water supplies, many people in rural areas do not have adequate wells, or the water from their wells is high in iron content or sulfate that makes the water smell like rotten eggs."

**—Jim Dinger,
Kentucky Geological Survey**

W R I T T E N B Y
J E F F W O R L E Y



Call them water scouts. Or sluice sleuths. From the sky and from underground—from satellite imagery to the depths of abandoned mines—researchers at UK's Kentucky Geological Survey (KGS) are working to find water to supply small communities in Eastern Kentucky.

Is water really in such short supply in the eastern part of the state? Just recently, Kentucky's Division of Water listed all counties in Eastern Kentucky, except three bordering the Ohio River, as being under a water "watch" or "warning" with regard to water supply.

"In addition to shortages in municipal water supplies, many people in rural areas do not have adequate wells, or the water from their wells is high in iron content or sulfate that makes the water smell like rotten eggs," says Jim Dinger, the head of the Water Resources Section at KGS. "Some people are hauling in water to cisterns, which can be expensive and inconvenient. Others are going out with milk jugs and

ROBERT ANDREWS (LEFT) AND JIM DINGER ARE USING REMOTE-SENSING DEVICES AND NOVEL DRILLING TECHNIQUES TO FIND HIGH-YIELD WELLS IN EASTERN KENTUCKY.

collecting water from roadside springs. This is obviously a health concern," he says.

One search-and-find mission, headed up by KGS geologists Dinger and Robert Andrews, involves using remote-sensing devices and novel drilling techniques to find areas of the Kentucky River Basin where high-yield wells can be drilled and groundwater supplies developed. Andrews is principal investigator on this High-Yield Water Project. The first two years of the study were funded by the University of Kentucky E.O. Robinson Trust; the project is currently funded by the Kentucky River Authority.

Dinger admits this is challenging work. "In other parts of Kentucky and the United States, large supplies of groundwater are found mostly in sandstone or gravel deposits hundreds of feet thick that extend for miles. These deposits act like huge sponges that soak up and store water. While the Eastern Kentucky Coal Field does have sandstone deposits, they are not hundreds of feet thick and don't go on for miles—these deposits are isolated on ridges that are separated from one another by intervening valleys," he explains.

The rocks of the Eastern Kentucky Coal Field, however, do have cracks and fractures in them connecting these sandstone deposits. These fracture zones act like drains and many contain large amounts of groundwater.

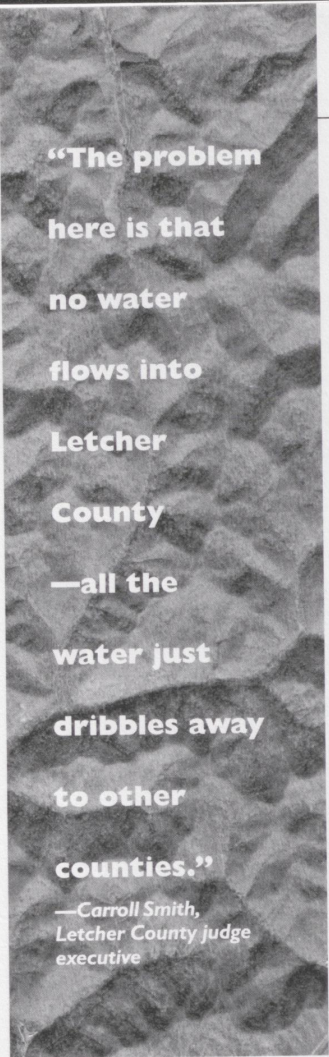
"What we're doing," says Dinger, "is trying to locate fractures that might provide sources of drinking water for small communities and towns in Eastern Kentucky." Even more important is to locate where these fractures cross one another, he adds, since this "crosshatching" means there's an even greater chance of finding large amounts of groundwater.

And this is where high-flying high-technology becomes a partner in this research.

"Examination of remote-sensed imagery—satellite images, low-altitude radar, and aerial photographs—reveals what appear to be lines or, as we call them, lineaments," says Andrews. "Though these lineaments can represent roads and power lines—even railroad tracks—they can also represent vertical fractures in the earth's crust. In addition," he continues, "these lines can represent surface features caused by fractures. For example, straight-line stream valleys are generally formed in fracture zones." This technique of using remote-sensing imagery to locate high-yielding ground-water supplies was pioneered by Richard Parizek of Penn State University and has been successful in the United States and other parts of the world.

Utilizing satellite imagery, Andrews selects lineaments and, from a database accessible to KGS researchers, creates overlays of man-made features to distinguish them from natural lineaments.

continued on page 18



**"The problem
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Letcher
County
—all the
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dribbles away
to other
counties."**

—Carroll Smith,
Letcher County judge
executive

Armed with these maps and other information, Andrews and Dinger climb into a KGS truck and head into Eastern Kentucky to begin their reconnaissance mission.

"We need to actually see if we've identified the lineaments correctly," Andrews says. During their field-check, they look for road cuts—hillsides that have fractures. "Optimally, we're looking for long fracture zones in the earth's surface. These zones allow groundwater to move more quickly than it would through denser rock material."

Once the researchers are satisfied that the lineaments mark good, potential water sources, they decide which spot would most likely be best to drill. But Dinger is quick to point out that the actual drilling is contracted out. "You won't find us on a rig anytime soon," Dinger says, adding, however, that their supervisory role does not end here.

"In the past few years, we've adopted a drilling technique called inclined drilling, which has been very successful," he says. Instead of the traditional approach—drilling straight down into the earth and hoping to hit a fracture that contains water—inclined drilling gives more of a cross section of information about the nature of the bedrock, maximizing the chance that the drillers will find a fracture with abundant groundwater.

"With inclined drilling," Andrews says, "we drill a hole around 250 feet down at a 40-degree angle from the land surface to see if we can find water-producing fractures. This hole covers about 190 lateral feet of the subsurface. Then we drill a traditional, vertical water well at the location of the fracture."

Finding water is a good start, Andrews says, but there also has to be a large enough volume to make the work worthwhile. "We hope to drill a well that will yield greater than 50 gallons a minute, which would be enough to supply water to at least a small community," he says.

So far in this project, Andrews and Dinger have supervised drilling at eight sites in Eastern Kentucky with, as Dinger puts it, "quite a range of results." At their first site, the Hitchens community in Carter County, the well produced only 3.5 gallons per minute, barely enough for one home; but it was drilled without using inclined drilling. The Oakdale site in Breathitt County,

however, was another story. The researchers identified lineaments and the drillers went to work. Using inclined drilling, they drilled a well that yielded nearly 98,000 gallons of water a day, greater than 99 percent of already-established wells in Breathitt County.

"This was exciting and very rewarding," Dinger says, adding that the researchers have chalked up similar successes in Clay, Knott and Letcher counties.

So, what's next?

Dinger explains that after the various water samples are tested back in KGS labs, it's up to the communities near these various sites to take it from there.

"The next step would be for the community to build a treatment plant close to one of these high-yield wells so the water can meet EPA standards," Dinger says. "With the good quality of groundwater we've been finding, this generally means that chlorination needs to be added to protect against bacteria." In the meantime, KGS researchers are continuing to refine their use of remote sensing and drilling techniques to locate fractures and large supplies of groundwater in the Kentucky River Basin, and they hope to extend this technique across the state to all communities short on water.

"Because these techniques continue to lead us to significant amounts of groundwater in Eastern Kentucky," Dinger says, "the survey has already conducted a workshop to teach these techniques to consultants who could apply them to other towns and communities in the Commonwealth."

Mining for Water

In a related project also funded by the Kentucky River Authority, KGS geologist Dennis Cumbie is working, too, to bring water to seven counties in the upper Kentucky River basin in Eastern Kentucky. In this steep terrain where adequate surface-water supplies are limited, Cumbie is looking for groundwater that has accumulated in abandoned, underground coal mines that may supply large quantities of water.

"The problem here is that no water flows into Letcher County—all the water just dribbles away to other counties," says Carroll Smith, Letcher County judge executive. "We've got the north fork of the Kentucky River, the Cumberland River and one of the forks of the Big Sandy River starting in this county, so as soon as it stops raining, the level of water in the rivers starts falling. In dry weather, from September to December, we get low on water, so the work Dennis Cumbie is doing out here—trying to determine the amount of water in abandoned coal mines—is important for us."

But even if large reservoirs of water can be located, how safe and appealing would water be that has been infiltrated by coal dust for years?

"The water pumped out of the mines is surprisingly good," says Smith, who has held the judge executive position for the past seven years. "It's low in oxygen, as you'd expect since it's not exposed to the air, and most of the dissolved minerals in it are very treatable. The bacteria level and general cleanliness of the water are excellent. The KGS labs haven't found any heavy metals, which I was worried about early on." Cumbie says that the next step in the process, once the water quality is determined, will be to pipe or pump the water into the creek where it will naturally flow down to Whitesburg and Blackie where treatment plants are already located.



DENNIS CUMBE SAYS THAT ABANDONED MINES ARE NATURAL STORAGE BASINS FOR WATER. THE CHALLENGE: HOW BEST TO GET THE WATER OUT.

He admits that his work in Letcher and six other counties in Eastern Kentucky is in some ways easier than the challenges Dinger and Andrews face. "Mines are natural basins where water has already collected," says Cumbe. "I'm not pumping water out of rocks. Also these mines are huge. One mine in southern Perry County encloses several hundred acres—five feet in depth and 60 percent full of water—that can equal hundreds of millions of gallons of water.

"Most things can be filtered out of water from mines. What you worry about in coal water are the things that are dissolved in it," Cumbe explains. Occasionally, this water can have high iron content, which is more of a nuisance than a health hazard, and it can be high in sulfate, which can cause the water to stink. "Though this isn't really a health problem, some of this water exceeds what the EPA calls 'esthetic standards.' This term refers mostly to odor and discoloration, iron being the main culprit. But these are problems that can be easily corrected with conventional treatment methods."

Since the general locations of the mines are well documented, Cumbe's biggest challenge, he says, is to try to figure out the best place to drill a well into the mine in order to maximize the amount of water tapped, or

"These mines are huge. One mine in southern Perry County encloses several hundred acres—five feet in depth and 60 percent full of water—that can equal hundreds of millions of gallons of water."—Dennis Cumbe

to find the locations where there is significant, natural outflow that can be captured for use. "I'm limited in my resources; I can't monitor every outflow in a huge mine, so I have to find as many outflows as I can, then prioritize," he explains. "I have to ask, 'Which outflows will be closest to the community that needs water?'"

Out in the field, Cumbe works with local coal operators, who take him to abandoned mines. "They know how much water they've had to pump out of mines; they know where water-filled areas should be," Cumbe says. He uses maps constructed from aerial photographs and tries to correlate the surface maps with sub-surface maps of the mine. "I select a site, then contract out drilling. I go with the drillers, hoping that one of several things won't go wrong," he says. "One danger, for example, is that they might drill into a coal pillar left in the mine instead of the space created by the mining activity."

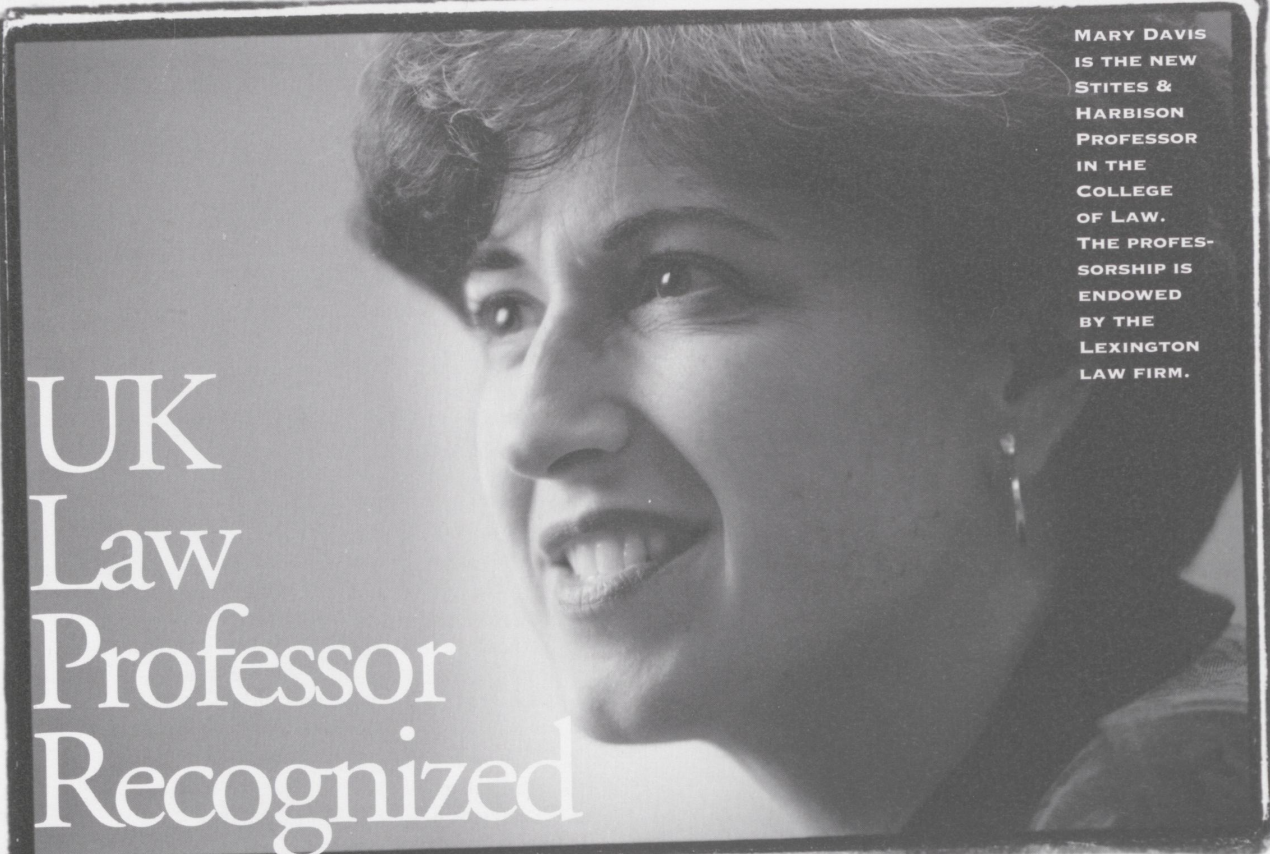
So far, Cumbe is batting 1.000 in the drilling challenge. "We're three for three right now, our biggest 'strike' being the Polly Number 4 Mine, located at Cow Branch in Letcher County," he says. The estimated storage volume of this mine is 260 million gallons with a recharge rate of 450,000 gallons a day.

How common is it for a community to get its water from an abandoned mine?

"It's been done for years," Cumbe says. "It's very common in Pennsylvania, and in West Virginia, over 70 public systems get their water entirely out of underground mines." He says that the city of Welch, West Virginia, which is about the size of Jackson, Kentucky (population 3,000), gets all of its water from two underground mines. "The water is generally run through an aeration-filtration plant and is chlorinated. Then it's ready for public use." Two communities in Kentucky presently use similar systems—Wheelwright in Floyd County and Fleming-Neon in Letcher County.

Although Cumbe is the primary UK contact for this project, he gets a lot of good help, he says. He consults with his colleagues at KGS and in the Kentucky Division of Water and the Kentucky Rural Water Association. KGS lab technicians analyze all water samples Cumbe brings back.

"I enjoy coming to work," he says. "I had never been around a coal-mining area until I started this job three years ago. This is important work, and it's rewarding to know you're helping the people in these communities." ■



UK Law Professor Recognized

MARY DAVIS
IS THE NEW
STITES &
HARBISON
PROFESSOR
IN THE
COLLEGE
OF LAW.
THE PROFES-
SORSHIP IS
ENDOWED
BY THE
LEXINGTON
LAW FIRM.

for Class-Action Expertise

Mary Davis admits that in law school she must have missed the class where the professor discussed the importance of being able to drive a large truck.

"A few years after graduation, I found myself defending the manufacturer of luxury yachts in litigation involving a variety of accidents allegedly from design or manufacturing flaws," says Davis, a professor in the University of Kentucky School of Law. "I ended up driving a truckload of yacht parts to the deposition, not the kind of thing I envisioned doing when I was in law school."

Davis's law career has taken her from college to the real world of courts and bitter confrontation and back again. Davis graduated from the Wake Forest University School of Law in 1985 and began to specialize in product liability litigation. She worked for six years in Virginia and North Carolina before returning to the university environment she enjoyed so much as a student. "I know it may be hard to believe, but I loved law school," she says. "I found it to be constantly stimulating and

always thought I would like to teach one day." Davis, the new Stites & Harbison Professor, has been at UK since 1991. She teaches product liability and mass tort litigation.

Davis says she remembers exactly when her interest in law began. "I was in high school. My mother told me a story one evening about my grandmother, who immigrated from Italy to Connecticut to marry," says Davis. "It was an arranged marriage, and my grandmother was just 16 then." Davis's grandmother had five young children when her husband died, and soon after was confronted with a staggering amount of legal paperwork and fees. About 50 percent of her husband's estate ended up in her attorney's bank account.

"That was shocking to me," says Davis. "I thought, well, that was obviously unfair. It was an impetus to start thinking about going to law school."

During her law studies, Davis became increasingly interested in mass tort law. "Those are cases that involve large numbers of people—class action—all being affected by the same type of defect," she explains. In her practice, she covered cases involving a variety of products, from asbestos to cars to

WRITTEN BY JEFF WORLEY AND SARAH LIGON

barbecue gas grills; most, she says, were complex and amazingly time-consuming.

"During my defense of a large electrical equipment manufacturing company in litigation involving asbestos-related injuries, I became convinced that there must be a better way to resolve disputes involving large numbers of people injured by the same course of conduct," Davis says. "My experience with that litigation gave me insights into my scholarship on class-action resolution of large-scale litigation."

She explains that at the time the law firm had enormous stacks of paperwork—legal filings—that came in every day in the handling of over 2,000 cases nationwide. Davis spent a lot of her time simply reviewing documents and managing paralegals to keep from being overwhelmed by the number of cases. "Much of the litigation at that level is administrative, and that's why I believe that class actions can be a useful tool to resolve such cases," she says. "The one-on-one method of adjudicating such cases is simply not feasible anymore."

Davis believes that mass tort class action should not simply be a device to settle cases. "A class-action determination of the liability of a company or companies for product-defect-related injuries could be useful in two ways—providing closure that victims need as to the question of responsibility, and determining responsibility that can be applied to pending cases," she says. These cases, she adds, can then be evaluated on the causal connection between the product and the injury, and on the victim's damages.

"Most product manufacturers fear class action because of the sheer size of what is at stake—large damages," she says. "If we separate the liability determination from the damages determination, that fear should be at least partially alleviated and the assessment of damages can proceed in the normal way, on a case-by-case basis. The way the current system works encourages lawyers to try to resolve tens of thousands of cases in full at one time, and product companies naturally rebel at that because of the enormous amount of financial exposure. Until the class action is used more as a liability-determining device

"Most product manufacturers fear class action because of the sheer size of what is at stake—large damages. If we separate the liability determination from the damages determination, that fear should be at least partially alleviated."

—Mary Davis

and not a settlement device, cases will not be resolved efficiently."

A related area that interests Davis is the problem of how well juries assess technological information and scientific data presented in a courtroom. With the technological explosion, bewildering to many of us, can we trust a jury of our peers to understand the issues?

"Some lawyers and law professors believe we could do away with the jury system in complex cases and let 'experts' handle them, but we lose a lot of involvement of very capable people in society whose opinions I think we undervalue by telling them they can't handle the complex cases. In my experience, a jury can handle many complex cases because they bring a wealth of background to a case."

She believes that the system could be improved, though, by a much greater use of neutral experts rather than those paid for by either party. "That is the real problem with technically complex cases—the parties bring in 'hired guns' to give the jury biased information, and the jury may find it difficult to separate the wheat from the chaff. I would endorse the greater use of neutral experts to assist, but not take over, the jury."

Davis's expertise and scholarship in the

product-liability area has recently been recognized nationally—she was elected to the American Law Institute in May 2000. Members are selected on the basis of professional achievement and demonstrated interest in the improvement of the law, according to the institute's new members guide.

"As far as my work with the institute goes, because of my background, I'll be involved in reviewing the state of tort law to assist in the institute's project to revise what we call the restatement of the law of torts," Davis explains. "I also plan to be involved in a project focused on international recognition of judgments."

In the meantime, Davis will continue to do what she loves best—teach. "This is the greatest job in the world," she says. "To evaluate these fascinating issues, to help someone learn about this system that is so fundamental to our society, to have the opportunity to work with the brightest future legal minds (our students at UK can compete on par with anybody)—it's incredibly gratifying." ■

Editor's Note: John Rogers, who teaches international law at the UK College of Law, was also elected to the American Law Institute last spring. Other current and former UK law professors who are members of the institute include Allan Vestal, dean; Thomas Lewis, professor emeritus; and Paul Oberst, professor emeritus.

WRITTEN BY
DEBRA GIBSON



Targeting Women's Health

Consider the following:

- ➔ Researchers now know that estrogen is important to a woman's health well beyond its role in the reproductive process. But how, exactly, does estrogen affect the heart, the brain, and the bones?
- ➔ Women in Kentucky have a significantly higher risk of getting ovarian and uterine cancer than women in the rest of the nation. The unanswered question: why?
- ➔ Coronary artery disease is the leading cause of death among post-menopausal women, but the indicators of cardiovascular disease such as chest pain present themselves differently in men and women. How should that factor into the diagnostic process?
- ➔ One-third to one-half of all women suffer some kind of abuse in their lifetime. In addition, 30 percent are diagnosed with an anxiety disorder. Who can help them and how?

These questions are part of a bold new focus on women's health at the University of Kentucky that includes \$15 million in funding for new research as well as the establishment of the UK Women's Health Center and a center for biomedical research in women's health. This work could lead to crucial findings related to women's health and to improved clinical care for women.

These new efforts will build from an already-solid foundation of research in women's health at UK. Phyllis Wise, the Shih Chun Wang Professor and chairperson of the Department of Physiology in UK's College of Medicine, has been researching the role of estrogen for more than a decade.

According to Wise, it has only been in the last 10 or 15 years that the National Institutes of Health began requiring that women even be enrolled in clinical trials. "It was assumed that results from fundamental and clinical studies that were performed in men could be applied to women," says Wise. "However, we now know that there are many aspects of our

"It has only been in the last 10 or 15 years that the National Institutes of Health began requiring that women even be enrolled in clinical trials. It was assumed that results from fundamental and clinical studies that were performed in men could be applied to women."

—PHYLLIS WISE

physiology that are gender dependent." Likewise, many diseases affect women more frequently than men and manifest themselves differently in women.

A new five-year, \$8.2 million grant from NIH will enable Wise to expand the scope of the research under way at UK and allow a cadre of researchers to interact and address synergistic issues. It will also establish the Center for Biomedical Research Excellence in Women's Health (COBREWH) at UK, which Wise will head.

Collectively, COBREWH researchers will examine how estradiol (the predominant and most potent estrogen in adult premenopausal women) and drugs that are related to estrogen—selective estrogen receptor modulators (SERMS)—affect a woman's neuroendocrine, central nervous, cardiovascular, and reproductive systems as well as behavior.

"We want to understand what estrogens do in young women and what happens when a woman reaches middle age and experiences menopause, and estrogen levels decrease dramatically," says Wise. "Before, we thought it was a simple matter of a change with one hormone that affected only a few organs—the ovaries, uterus, cervix and a few others. Now we know it is much more complicated."

Wise likens the inner-workings of a woman's body to an orchestra.

"For Beethoven's Third Symphony to be played successfully, all the instruments must come in at the right time," Wise says. "If the violas aren't there or don't come in at the right time, it won't sound right. This is also true with a woman's body. Estrogen triggers regular menstrual cycles. If the right signal doesn't come at the right time, the cycle is not regular," she says.

Wise adds that estrogen affects changes far beyond the ovaries and the reproductive system. "We now believe estrogen is critically involved in our cardiovascular system, the cerebral cortex, the hypothalamus, and the bones, for example, but we don't know pre-



THE SHIH CHUN WANG PROFESSOR IN THE DEPARTMENT OF PHYSIOLOGY, PHYLLIS WISE HAS BEEN RESEARCHING THE ROLE OF ESTROGEN FOR MORE THAN A DECADE.

cisely how it is involved."

This research will have implications for millions of women. Currently, more than 35 million American women are postmenopausal and more than one million will become menopausal each year.

"Until 100 years ago, women didn't live much past menopause, but now the average lifespan for women is 83 years," Wise notes. "Women now live 30 years not producing estrogen. Women in their 50s and 60s complain of memory loss and depression at menopause, and we know their risk of cardiovascular disease increases. Their risk of stroke is much greater, too, and the injury associated with a stroke is greater. We don't know very much about what estrogen does for us, good or bad. We need to understand how estrogen affects all of these areas."

The five-year studies will begin with fundamental cellular and molecular research, move into translational research using animals, primarily mice, then move into drug development and testing before concluding with clinical trials.

Wise has also received \$3.75 million from the National Institute on Aging, part of NIH, for another project. This study will focus on what happens as women age that prevents the

ovaries from functioning as they did during the reproductive years and whether estrogen continues to protect against injury during aging.

Ultimately, this research will be important not only to women but to their health-care providers as well. It will certainly be important at the newly established UK Women's Health Center. The result of five years of organization and planning, the center is the first of its kind in Kentucky. It officially opened in the fall of 2000 with five missions—clinical care, leadership, education, research, and community outreach. (See page 25, "Under One Umbrella," for details.)

These missions come together in a three-year, \$821,000 grant from the U.S. Department of Education to develop a core multidisciplinary women's health curriculum. This educational reform could change the way all health-care providers diagnose problems of female patients. The curriculum will be tailored to the needs of each of UK's five colleges in the medical center.

"We started looking at this two and a half years ago," recalls Deborah Kwolek, director of the center, principal investigator on the curriculum project, and an assistant professor

continued on page 24

"Treatments for women may need to be different. Heart disease in women is different than in men, for example. If a woman has diabetes, she has a stronger risk factor for heart disease than a man."

—DEBORAH KWOLEK



of internal medicine in the UK College of Medicine. "I was very much aware of Dr. Sandra Levison's work to establish the Women's Health Education Program at the Hahnemann School of Medicine in Pennsylvania. They have been making many advances in terms of women's health education.

"At UK we started by raising awareness and doing needs assessments among health science students. We also did some daylong faculty development workshops to help us better understand the major issues and what we could do. Then we developed a Women's Health Education Team, made up of two faculty members from each college. They have been meeting monthly for the past two years to consider possible curriculum changes."

Receiving the Department of Education grant enabled Kwolek and her team to do even more. Their work will ultimately affect a whole generation of health-care providers.

"We are concentrating on three areas," Kwolek says. "The first is a core lecture on women's health and gender-based medicine, which is included in the curriculum in each college. The second is professional development for faculty in women's health. This year, a 12-person team is developing core curriculum. Each of the five colleges has a task force that will then adapt core curriculum to the needs of their students.

The third aspect is hands-on workshops using what Kwolek calls "standardized patients," actors who describe symptoms associated with one of six problems common to women—heart disease, diabetes, depression, sexually transmitted diseases, osteoporosis, and domestic violence. The students must diagnose the problem and prescribe treatment.

The results from practice sessions using this technique reveal a gap between what the patients say and what the students hear as well as a gap in the students' knowledge about specific medical needs of women, according to Kwolek.

"Treatments for women may need to be different," she says. "Heart disease in women is different than in men, for example. If a woman has diabetes, she has a stronger risk factor for heart disease than a man. Many students don't know that. Our goal is for all students to know which treatments work better for women and which treatments work better for men. The goal isn't just to improve women's health, but to improve care for all patients. The students leave the exercise with core knowledge on all these very common conditions."

That knowledge will be disseminated to 15 collaborating institutions nationwide, according to Kwolek. Her work also ties directly into

MEDICAL DIRECTOR OF THE CENTER FOR BIOMEDICAL RESEARCH EXCELLENCE IN WOMEN'S HEALTH, DEBORAH KWOLEK IS DEVELOPING A NEW CURRICULUM FOR HEALTH-SCIENCE STUDENTS THAT SHE HOPES WILL RESULT IN IMPROVED CARE FOR ALL PATIENTS.

that being done in other departments on the UK campus.

Emery Wilson, dean of the UK College of Medicine, leads a program called Building Interdisciplinary Research Careers in Women's Health (BIRCWH). The program is funded by a five-year, \$2.5 million grant from the National Institutes of Health.

The two primary goals of BIRCWH are to provide junior faculty with state-of-the-art multidisciplinary training in research relevant to women's health and to encourage new collaborative research focused on improving women's health.

"We are attempting to develop faculty members with an interest in research and to provide them with the skills necessary in order for them to be successful in doing research," Wilson says. "This also provides an opportunity to develop women's health at the univer-



EMERY WILSON, DEAN OF THE UK COLLEGE OF MEDICINE, LEADS BUILDING INTERDISCIPLINARY RESEARCH CAREERS IN WOMEN'S HEALTH, A PROGRAM TO PROVIDE JUNIOR FACULTY WITH STATE-OF-THE-ART MULTIDISCIPLINARY TRAINING IN RESEARCH RELEVANT TO WOMEN'S HEALTH.

sity. We're trying to bring people to obstetrics, internal medicine, neurology, and other fields who are interested in women's health and developing research along those lines."

Wilson says the project will particularly focus on areas that have not received much national attention.

"For example, we know that there are more instances of gynecological cancer (ovarian, uterine) in Kentucky than in any other state," he notes. "Is that a problem with women not getting adequate screenings or is it for some other reason?"

There are any number of research possibilities, according to Wilson, who says there are three areas of focus this grant will support: regulation of menopause and its repercussions on women's health, nutrition-related illnesses and their impact on women, and gender issues and drug abuse.

Phyllis Wise and Claire Pomeroy, chief of infectious diseases at UK, will coordinate the programs and the appointment of BIRCWH scholars. Each junior-faculty scholar will work with a senior researcher and participate in workshops in various aspects of research, including grant writing, statistics, and ethics.

"This program gives us an opportunity to bring all of these issues together," says Wilson, "and to do two things: develop new faculty members and focus efforts in women's health. It is important to get women involved in their own health care. Women are usually the ones who care for the entire family. If we can get them involved and begin to improve the health of women in Kentucky, we can, through them, begin to improve the health of all Kentuckians."

The focus on women's health will have a domino effect, according to James W. Holsinger Jr., chancellor of the UK Chandler Medical Center.

"We really leapfrogged into a significant national leadership position with the coming together of these grants," says Holsinger. "This prominence nationwide will encourage more people to come to UK to do research on women's health, which will build a major focus on women's health here and result in clinical advances. That cannot help but make a real difference in the health care women receive." ■



Under One Umbrella

The idea is so simple that it should be common practice: put all the primary health-care services that women need in one place.

And this is exactly what happened at the University of Kentucky when the UK Women's Health Clinic opened in April 2000.

"We try to have one-stop shopping for women with primary-care medicine, gynecology, and psychiatry," says director Deborah Kwolek. "Our health-care providers have particular expertise and interest in women's health. They keep abreast of all national information on key findings. This is not generic medical care. It is more targeted to and sensitive to the needs of women. We have expertise in hormones and how women patients are distinctly different from male patients."

The reception from women is evident in one fact: the clinic already has more patients than the three physicians, three resident physicians and four nurse/practitioners can handle. They are hoping to expand soon to meet the demand.

"We are a small model clinic," Kwolek notes. "This isn't the solution to take care of all women. Our goal is to help other providers both in the UK network and the state emulate this model so the diverse needs of women can be taken care of throughout Kentucky."

The clinic is one of five missions of the UK Women's Health Center. In addition to the clinic and the research activities, the center is also developing leadership programs among women faculty, is involved in community outreach programs, and is conducting regular education programs.

Headed by Edythe Lach, the leadership program includes a monthly luncheon series and a training program called Circles of Power that immerses women in a yearlong, intensive study of leadership skills. There is also a regular recognition program to celebrate achievements of women in leadership positions.

Linda Kuder, associate director for education and community services at UK's Sanders-Brown Center on Aging, heads the community outreach program and its main event—an annual statewide summit on women's health. Now in its fourth year, the conference brings together legislators, health-care providers, and staff from public health departments to discuss the status of women's health.

Monthly women's health "grand rounds," which provide continuing medical education to health-care providers, and are transmitted to 13 sites across the state, feature national speakers addressing health-related issues important to women. There is also an annual women's health conference to provide continuing education on women's health topics.

"Health care used to look at women as men with a few added parts," Kwolek notes. "The 'normal' human was a 70-kilogram man. Now the paradigm is shifting. We see two sexes—two equal but very different sexes. Our new women's health initiative is about being advocates for women, and as we study women we learn more and more about the differences. This focus will put the University of Kentucky at the forefront of a new era in health care for women." ■



RESEARCH

FOR THE FUTURE

We are pleased to bring you a new feature that will highlight some of the recently funded projects at the University of Kentucky.

The following projects were approved for federal funding in 2001. A special thank you goes to the Kentucky congressional delegation for their hard work in support of the research efforts of UK. In particular, Senator Mitch McConnell, Senator Jim Bunning, Congressman Hal Rogers, and Congressman Ernie Fletcher have made the appropriation of over \$9 million in research funds to UK a high priority. Without their leadership and support, these new projects, important to both the Commonwealth and the nation, would not have been possible.

Advanced Genetic Technologies

- This \$475,000 project from the USDA will enable plant and animal scientists from the UK College of Agriculture to develop and use a multidisciplinary genomics and genetic analysis facility to solve agricultural problems. The project will involve extensive coordination with other UK initiatives in the areas of bioinformatics, structural biology, functional genomics, and proteomics.
- Advanced genetic technologies offer tremendous potential to eliminate plant and animal diseases, enhance the nutritional value of food, exploit renewable biological sources of fuel and industrial feedstocks, and develop new uses for agricultural plants and animals.
- The principal investigator is Chris Schardl, Department of Plant Pathology.

C1 Chemistry Project

- The U.S. Department of Energy has added \$1.4 million to UK's C1 chemistry research project that will produce ultra-clean, high-efficiency transportation fuel (diesel fuel and gasoline) and high-value chemicals. Faculty and students from UK, the University of Utah, the University of Pittsburgh, West Virginia University, and Auburn University are collaborating on this project, now in its second year and administered by CFELS, the UK College of Engineering's Consortium for Fossil Fuel Liquefaction Science. C1 chemistry refers to the conversion of molecules containing one carbon atom, such as methane, carbon dioxide, methanol, and synthesis gas. CFELS director Gerald Huffman is overseeing the project.

Paducah Gaseous Diffusion Plant

UK and University of Louisville epidemiologists will collaborate in investigating the impact of exposure to radioactive materials on people working in and around the gaseous diffusion plant in Paducah, Kentucky. The DoE and National Institute of Occupational Safety and Health will provide \$1.75 million for the project this year and \$2.5 million for each of the next two years, according to project director F. Douglas Scutchfield, UK director of the Center for Health Services Management and Research and director of the School of Public Health. The researchers will look for such things as cancer incidence and prevalence of those cancers most associated with exposure to radioactivity (lung, bone, thyroid, and bone marrow cancers).

Excalibur Launch Technology

This is the second partnership between UK's Center for Robotics and Manufacturing Systems (CRMS) in the College of Engineering and Truax Engineering, Vista, California. Excalibur is a \$600,000 project sponsored by the U.S. Department of Defense to design a lightweight heat exchanger that will be used with a reusable rocket-launch vehicle. Alan Male, CRMS director, will oversee the work of eight CRMS and mechanical engineering faculty and graduate and undergraduate students. An unmanned shuttle vehicle that can launch items into orbit will ultimately reduce the cost of missions into near space.

Forage-Based Livestock Systems

Forage-based livestock production is of vast economic and agricultural importance across mid-America. This \$375,000 project from the USDA will allow eight UK agronomy and animal sciences faculty to research the nutrition and physiology of grazing animals, which will enhance weight gain, product quality and farm profitability. The researchers will also work on post-harvest physiology to improve forage quality and minimize loss of stored forages needed during periods of slow pasture growth. Integrative studies of landscape-forage-livestock systems will lead to innovative management practices that will enhance this highly sustainable agricultural ecosystem. Mike Collins, Department of Agronomy, is the principal investigator.

Intelligent Transportation

Researchers at UK's Kentucky Transportation Center improve highway safety for all travelers by working on issues related to the safety of trucks. This \$1.5 million a year project from the U.S. Department of Transportation will develop computer diagnostic equipment to monitor truck engine and safety performance over the next three years. Providing detailed information about the truck's control systems will make it easier to maintain and repair the vehicles. This is a joint project with Veridian Engineering in Arlington, Virginia, and the Kentucky Transportation Cabinet. UK's principal investigator is center director Paul Toussaint.

Legal Training Facility

The U.S. Department of Justice has funded a \$750,000 video teleconferencing facility for the UK College of Law. According to Dean Allan Vestal, the facility will expand the role of the law school and build on its initiative to provide extensive access to legal education. The teleconferencing facility will increase UK's current capabilities in training prosecutors throughout the state and provide alternative dispute resolution programs to government agencies.

New Crop Opportunities

College of Agriculture multidisciplinary teams from horticulture, agronomy, agricultural economics, entomology, biosystems and agricultural engineering, and plant pathology are involved in research for the New Crop Opportunities Center, established in July 2000. The USDA is funding the project at \$750,000 for one year. Research and extension efforts are focused on economically sustainable crop production, new crops, and expanded crop uses in Kentucky, as well as profit and risk potential analysis and marketing of specialty crops. Initial research involves peppers, blackberries, native plants and under-utilized landscape plants, greenhouse crops, and special varieties of corn, soybean and wheat (grain crops already being grown by the state's farmers). Dewayne Ingram, Department of Horticulture, and Larry Grabau, Department of Agronomy, are heading up this project.

Precision Agriculture

Precision agriculture uses technologies such as GPS (global positioning system) and GIS (geographic information system) to manage crop production by the square meter rather than traditional "field-average" management. Farmers using precision ag can enhance overall profitability while reducing nutrient and pesticide loading of the environment. Since 1994, UK researchers have been engaged in basic and applied research in areas such as soil fertility, remote sensing, variable-rate application equipment, yield-monitor testing, and development of yield-measurement techniques that can be used on the smaller, diverse farms that populate the Commonwealth. The USDA is funding the project at \$750,000 for one year. Scott Shearer, Department of Agricultural Engineering, and Tom Mueller, Department of Agronomy, are heading up this project.

Reclamation of Mined Lands

Over 250,000 acres of land in Kentucky have been impacted by surface mining, and another 1.6 million acres have been designated for coal extraction. Most of the land mined since 1978 has been heavily compacted and, although revegetated, could remain unproductive for the next 300 years. This \$2 million-a-year project from the U.S. Forest Service and Office of Surface Mining will enable UK researchers to work with state and industry partners over the next three years to reclaim 3,000 acres in three areas. The researchers will use new methods that will result in high-value hardwood timber, wildlife habitat and increased carbon sequestration (a process of trapping carbon dioxide in reservoirs beneath the Earth's surface). Don Graves, UK Department of Forestry, will oversee the project.

Wheat and Barley Scab Initiative

UK researchers are part of a 19-university consortium working on the \$6 million U.S. Wheat and Barley Scab Initiative charged with eliminating head scab as a threat to the wheat and barley industries. The USDA has provided \$60,000 to David Van Sanford, Department of Agronomy, Donald Hershman, Department of Plant Pathology, and several UK graduate students to develop resistant varieties and evaluate chemical control of the disease.

MARTIN SCHOOL'S HAIST WINS NATIONAL AWARD

WRITTEN BY
JEFF WORLEY

As a girl growing up in Milwaukee, Meg Patrick Haist would sometimes find a stranger at the table when she came down to the kitchen for dinner. These occasions, Haist recalls, were always interesting and memorable.

"I remember one couple in particular, who were both blind; they became part of our family. My mother had met them through an organization called Art Reach, where she was a volunteer. Through her work, she was clearly making a huge difference in other people's lives—and in her life."

Haist, now a doctoral candidate in the UK James W. Martin School of Public Policy and Administration, credits her mother with being an excellent role model for the importance of civic involvement. "These positive experiences clearly influenced my belief in the power of individuals to change things for the better," she says.

This lifetime interest in civic involvement is at the heart of a research paper Haist wrote last year titled "Civic Engagement: Why Do We Get Involved? Motivation, Opportunity and Mobilization." Her paper, which examines the reasons behind the apparent long-term decline of civic involvement and the effectiveness of our political process, won the 2000 Pi Alpha Alpha Doctoral Student Manuscript Award. This honor is given annually by the National Association of Schools of Public Affairs and Administration for the best paper written in the United States by a Ph.D. student.

Haist says she was "absolutely stunned" to win the award, and for a very good reason: she didn't know her paper was even in the running.

"Dr. [Ed] Jennings, my dissertation advisor, submitted the paper on my behalf—I didn't even know he had done this," she says. "I only found out a week

before the luncheon where I was presented the award. It's a thrill to be able to represent the department, since they have done so much for me here in terms of research support."

Terming Haist's paper "a marvelously executed analysis," Jennings adds that her research focuses squarely on the effects of motivation and opportunity on civic engagement and helps point the way toward



a diagnosis of the challenges to civic involvement and how to enhance civic engagement. Jennings is a professor of public policy and administration in the Martin School.

Haist is articulate and animated when she talks about the decline of civic involvement at all levels of government in the United States.

"Memberships in voluntary associations have declined by generation," she says, "and though Robert Putnam, the leading scholar in this area, believes the major reason is probably television watching, I wanted to look at other factors that have led to this decline." Specifically, Haist discusses the factors set out in her paper's subtitle: motivation, opportunity and mobilization.

"The motivation to be involved has to do with a person's family background, whether or not you were brought up in a home where civic duty and service were

common. Opportunity has to do with constraints on our ability to be involved—such things as low income, a low-prestige job, lack of exposure to what it means to be involved, the amount of 'free time' a person has, and so forth."

In her paper Haist distinguishes between passive and active involvement. "Real involvement is a lot more than simply carrying around a membership card to some organization," she says. "Do you go to meetings? Do you spend time on a committee in some organization? Do you go door-to-door come election time and talk with neighbors about the candidates you're backing?" Such activities define involvement and are important, Haist believes, because they build norms of trust and reciprocity and cooperation between people. These norms have a positive effect upon the community and its relationship with local government.

Why should a person be civically involved at all?

"If all you do is sit at home and watch TV or play on your computer, I believe that clearly stunts personal growth," Haist says. "These passive ways of spending time don't promote the sense of us 'all being in it together.'"

Haist believes that the most impact we are likely to make is by working in our local community. "We obviously need government to do certain things that the private market doesn't do, but we also need individuals to fill in where government can't do that good a job," she says.

Haist, who is married to Steve Haist, a physician in internal medicine at the UK Chandler Medical Center, plans to work full-time on her dissertation in 2001 with the goal of receiving her Ph.D. in the spring of 2002.

A NEW UK VOICE ON THE "SCIENCE OF CHOICE"

When asked where he'd like to start in a discussion of economics, David Wildasin sits back in his swivel chair on the fourth floor of the Patterson Office Tower, searches the gun-metal gray sky, and, probably without knowing it, paraphrases a line from Mick Jagger: "You can't always get what you want."

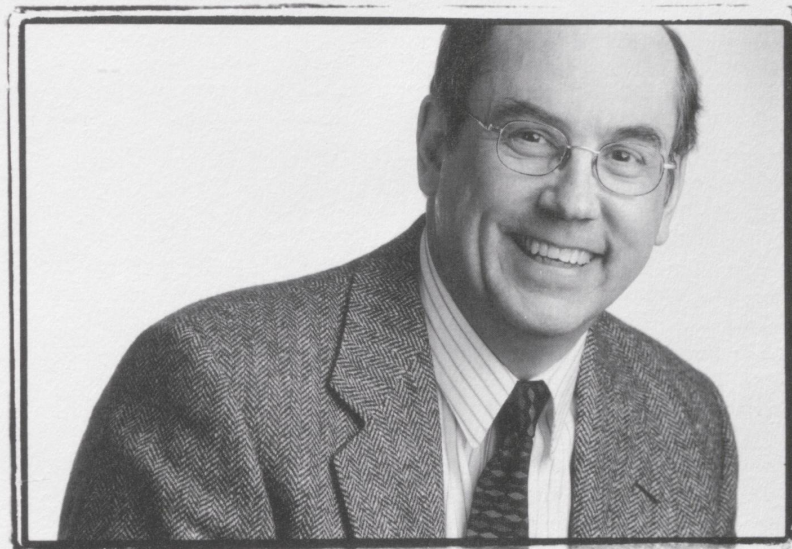
Wildasin's emendation is, "We can't have everything we want."

"Economics is all about tradeoffs, about scarcity," says Wildasin, the new chair of public finance at UK's Martin School of Public Policy and Administration. "Sometimes, economics is called the science of choice. It's also been known, more pejoratively, as 'the dismal science,' because we all have to make difficult choices in our lives; there are no free lunches out there."

"Since the Martin School's strength, historically, has been in the area of public finance, when we received the RCTF [Research Challenge Trust Fund] funding for an Endowed Chair of Public Finance, our faculty made a wish list of persons that we would target in recruiting," says Genia Toma, director of the Martin School. "David Wildasin is so well known in this area that we really didn't think we could attract him here. He clearly enhances our reputation and will be a tremendous asset not only to the graduate students but to the Commonwealth."

"The RCTF and related developments were a big factor in my coming here," says Wildasin, who was recruited from the Department of Economics at Vanderbilt University. He is especially known for his work on state and local public finance and "fiscal federalism," a subject he has studied since his graduate school days at the University of Iowa in the mid-'70s.

Wildasin explains that the question of public finance has been a concern in this country since the days of economist Adam Smith. "Over 200 years ago, Smith talked about what role the public sector should



play in governing economic activity. Should we let markets rule? Should we have lots of regulations? What's the right tax policy?" He admits that one reason this topic engages him so much is that the role of government in society is a perpetually hot issue.

Education is one area, he says, where government involvement has grown dramatically. For example, 150 years ago there was very little government participation in education, but in the last 50 years there's been substantial growth in the share of local school spending that gets supported by state governments. A continuing emphasis, he says, is funding directed toward poorer school districts within states.

"It's a commonly shared value in our country that there ought to be some basic level of education all kids get exposed to," Wildasin says. "And I believe states ought to be involved to some degree in remedying disparities in educational opportunity." But, he adds, this is not a simple issue.

continued on page 30

"IF PEOPLE IN
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THE EDUCATION OF THEIR
CHILDREN, SHOULD WE
PROHIBIT THEM
FROM DOING SO?"

—DAVID WILDASIN

"If we find children in a poor school district who are not getting the quality of education they might get in a richer school district, it's easy to say you want to do something to remedy that," says Wildasin. "However, if people in a wealthier community decide they want to put extra money into the education of their children, should we prohibit them from doing so? Few people would object to parents spending their money on improving opportunities for their children, yet this inevitably creates educational disparities among children."

Education, he adds, is such a sensitive issue because a person's life prospects are so heavily influenced by his formal schooling. "It bothers us that a person's lot in life can be determined by his parents' lack of wealth. That's one of the reasons for public sector involvement in education—to level the playing field to some degree by trying to make sure students have the basic skills they need to be successful in life."

Government involvement in public education is only one area of interest for Wildasin. He is also interested in the funding of local public services and the effect this has on a community. "Whether people decide to stay in a community or leave has a lot to do with how well public services are financed; such things as health, public transportation and safety are all important."

"Economists talk about people voting with their feet. The idea of a mass exodus from an area keeps local governments from—how to say this?—making ridiculously bad policy decisions."

He adds that migration can usually be seen as dramatic only over a period of years, and that local governments in their response to citizens' needs can rarely boast of huge successes or lament significant failures. One of his former residences, though, was "scarily close" to failing, Wildasin says.

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"When I lived in Washington, D.C., working with the World Bank in the Policy Research Department in 1996-1997, the city was coming close to being a significant failure. Crime in the district was up, property values were plummeting, the roads weren't being kept up, and there was a terrible problem with the city water—to the point that city health officials had to warn people about its use."

In the past decade, Wildasin has been focusing on public finance in the context of European economic integration and in developing countries where rapid reform of governmental institutions is leading to a rethinking of how governments should be financed and what their basic functions should be.

Graduate Alumni:

*We want to
feature you!*

- Tell us about your current position, company/institution and location, and career highlights, including past positions, projects and awards.
- List your undergraduate and graduate degrees, including year conferred, discipline and institution.
- Submit name, address, home and office phone numbers, fax number, and e-mail address.
- Include a black and white publicity photo or a good-quality color photograph of yourself for possible publication with your biographical information.

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KIOSK

REID IS NEW APPALACHIAN CENTER DIRECTOR

In 1968 Herbert Reid was a newly minted Ph.D. in political science who found himself in a bountiful job market. "Those were very different times," Reid says from his new office in the University of Kentucky's Appalachian Center. "The jobs were out there for young scholars in the arts and sciences." Reid recalls that months before he successfully defended his dissertation, he had three job offers—from a Canadian university, from San Francisco State, and from the University of Kentucky.

"One of reasons I chose to come to UK was because of the university's Appalachian connections," says Reid, who grew up in the Ozark Mountains of northwestern Arkansas. At UK, he would go on to be one of the founders of the Appalachian Center which, he says, came into being as a result of a lot of interest and hard work by several people with UK connections.

"In the early and mid-'70s, some of our students and quite a few faculty felt the time was right for such a center," Reid recalls. "One of my students and now a leading public interest lawyer in Lexington, Joe Childers, spent a lot of time trying to spark interest, as did UK sociologists Dwight Billings,

John Stephenson and David Walls." In 1977, the center was created in order to link UK resources with Appalachian communities in programs of research, instruction and service.

Reid says that as the new director of the center, he hopes to build on what has already been accomplished, particularly under the leadership of former director Ron Eller, who has returned to the UK history department where he is a full professor.

Reid is especially excited by the Project for the Civic & Environmental Commons, initially designed in 1998 by Reid and his wife Betsy Taylor, an anthropologist. This project is the core program of the new center.

"Across Appalachia, there are people coming together to try to build caring communities, sustainable local economies and to preserve their natural and cultural heritage. Under the Project for the Civic & Environmental Commons, the Appalachian Center is working to make academic resources more useful and accessible to communities in their civic and economic revitalization projects," says Reid, who has spent his entire academic career at UK.

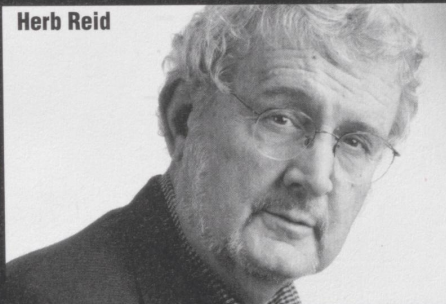
One challenging aspect of this program, he says, is to get faculty involved in mod-

els of research and teaching that are clearly place-oriented and to focus more on regional involvement and responsibility. "Any time you try to put to-

gether an academic partnership on a project, you're bringing together people with different histories, cultural experiences and orientations," Reid says. "What has to happen is the emergence of a common vision of the better world we're seeking."

The Appalachian Center also continues to be associated with the Appalachian Rural Education Network, which is composed of some of the most dynamic schools and regional professional partners in Eastern Kentucky and southwest Virginia. The network began in January 1997 under a grant from the Annenberg Rural Challenge, whose goal is to discover and encourage "genuinely good, genuinely rural schools," says Reid. As a result of this project, schools in Eastern Kentucky and Western Virginia in the last three years have gotten new equipment, including computer software and cal-

Herb Reid



culators, and new curriculum developed by their teachers. Currently, 24 schools are participating in this project.

"Our ultimate responsibility is to the people in Appalachia, especially those who send their kids to UK," says Reid. "I can attest to ways this center and its programs have helped students deal with not only the problem of Appalachian stereotypes, but also how it continues to help recapture the history and social knowledge of Appalachian communities."

"Dr. Reid brings vast practical experience with the social dynamics of Appalachia as well as a fine academic reputation for scholarly research to this position," says Fitzgerald Bramwell, UK vice president for Research and Graduate Studies. "We are pleased that he has accepted the challenge to lead the Appalachian Center into the new century."

—JEFF WORLEY

NEW NETWORKING ALLIANCE AT HARDYMON BUILDING

The new UK Alliance for Networking Excellence, various industrial partnerships, and 10 new scholarships were announced last fall in the dedication ceremony for the \$4.8 million James F. Hardymon Building.

The two-story, state-of-the-art facility on the corner of Maxwell and Rose streets brings together faculty and students from the College of Engineering, other academic and corporate researchers, and UK Communications Systems. The collaboration of these groups is central to the mission of the UK Alliance for Networking Excellence.

"The 27,000-square-foot building was designed around the concept of collaboration, with open space and furnishings that support fluidity of movement among team members and accommodate various types of interaction," says Doyle Friskney, associate vice president for Information Systems. "We can facilitate multidisciplinary research with other UK faculty, researchers at other institutions, and corporate leaders and innovators."

The UK Alliance for Networking Excellence is equipped with the most current technology and high-speed computing access capabilities to support research of evolving network communications sys-

tems. The UK Laboratory for Advanced Networking, made up of faculty and students from the computer science and electrical engineering departments, occupies the entire second floor of the building.

According to Jim Griffioen, director of the advanced networking lab, "the collaborations going on here are best captured by the term 'Metaverse,' which is the over-arching theme that ties all of our research interests together." Griffioen describes the Metaverse as a new model for networked communication and collaborative interaction that will ultimately expand the way we interact with computers and with each other.

"We're working on new protocols, or language, to transmit data for collaborative environments where users in different locations can interact with each other, or a user can interact virtually with real-world objects or models," Griffioen explains.

A number of novel technical approaches from different disciplines are brought together in the Metaverse theme. UK researchers have built an immersive display room, using off-the-shelf PCs, where images are displayed on the walls instead of a monitor, surrounding the user. The room is used to



test the communications systems needed to support this new environment—network techniques and protocols for moving massive amounts of data across a computer network. This prototype facility is being designed for use by academic researchers, industrial partners and educators.

Education is a critical component of the Alliance. Instructional programs will be developed to train UK students in networking and data communication skills that will be demanded by technology companies across the Commonwealth and the nation. In addition, corporate partners are invited to invest in the education and mentoring of students through the UK Alliance for Networking Excellence Corporate Scholarship Program. The scholarships provide full tuition for two years to students with a declared focus in advanced networking and innovation, and present many opportunities to be-

come involved in real-world challenges and opportunities.

Current corporate partners include Cisco Systems, Dell, GartnerGroup, IBM, MCI/WorldCom and Verizon.

The networking and communications systems focus at the Hardymon building enhances UK's position among the national leaders in academic high-speed computing. Recently, UK's new supercomputer placed the university 10th among all high-performance academic computer centers in the United States and 200th in the rankings of the top 500 supercomputer sites worldwide. UK is currently involved in the development of Internet II and was the lead partner in the development of SEPSCoR, a research network connecting six southeastern universities. UK is also a regional partner in the National Science Foundation's Partner-

ADHD & STORYTELLING

ships for Advanced Computational Infrastructure super-computer grant awarded to the National Computational Science Alliance.

UK's new Alliance headquarters is named in honor of UK College of Engineering alumnus James F. Hardyman, retired CEO of Textron Inc., a \$10 billion global company with aircraft, automotive, industrial, and finance operations. Hardyman's gift to UK in February 1999 established a chair in networking in the Department of Computer Science and a chair in manufacturing in the Department of Mechanical Engineering, as well as five graduate fellowships for students in the dual B.S./M.B.A. program in the College of Engineering and the Carol Martin Gatton College of Business and Economics. The Maysville, Kentucky, native is a former member of the University of Kentucky Board of Trustees.

—DEB WEIS

It's Saturday afternoon and Matt, a Lexington fourth-grader, is curled up in an armchair in the living room. He's watching a family sitcom. Toys and storybooks lie scattered on the table beside him.

Sound typical? Maybe so, but look again. A corner video camera is quietly recording Matt's reactions to the television. The sitcom is taped from a show that no longer airs, the toys have been strategically placed around him, and he's in a house owned by the University of Kentucky.

Matt and many other children who spend afternoons in this living room have what some researchers call the most widespread child behavior disorder today: ADHD, attention deficit hyperactivity disorder. The monitored television-viewing is part of ongoing research by UK psychology professors Richard Milich and Elizabeth Lorch into how kids with ADHD understand the world around them.

Children with ADHD typically have difficulty staying focused on tasks. "They engage in impulsive, sometimes inappropriate behavior,

like yelling in class," says Milich. This behavior creates major academic problems for most of the children, he adds. "They're held back more often, they fail subjects more often, and they're less likely to go to college than kids with similar intellectual abilities or kids from similar backgrounds."

Milich, a clinical psychologist interested in children with ADHD, and Lorch, a developmental psychologist interested in using story comprehension to track typical child development, recognized common research interests when Milich joined the UK psychology department in 1985. In 1986, the two began using television programs to study story comprehension in kids with ADHD, and have continued their collaboration ever since.

Funded by the National Institute of Mental Health, Lorch and Milich recruit children with ADHD as well as children without the disorder, and study them individually at the UK

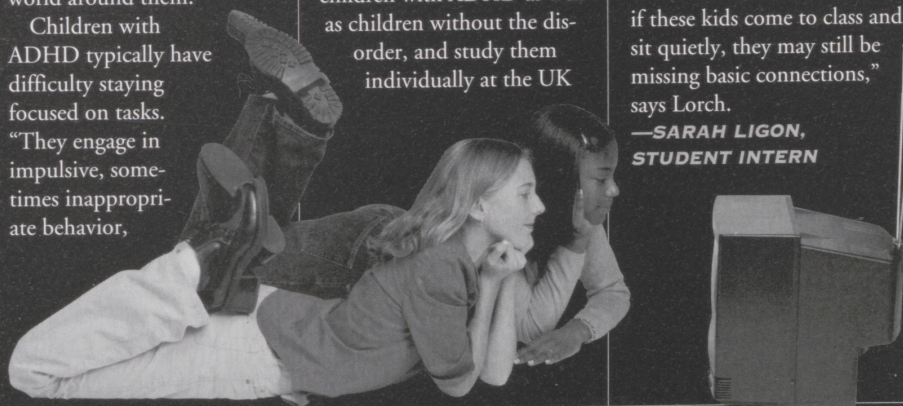
house off-campus. Sometimes the kids watch situational comedies such as "Growing Pains" or "Rugrats," and answer questions about what happened in the story and why. At other times, they are given wordless picture books and asked to tell their own stories to connect each picture. Both of these methods bypass the reading difficulties often associated with ADHD.

Milich and Lorch soon found out that although children with ADHD had little problem remembering specific events in the television stories, they had difficulty linking up the causes and effects in the story. They knew what had happened, but not why.

"This may get in the way of some social situations children experience," says Lorch. "If they don't understand the motivations of another child, they're more likely to get in a fight, for example."

Milich and Lorch hope that their research may help teachers and clinicians develop academic programs better tailored to the children's needs. "Even if these kids come to class and sit quietly, they may still be missing basic connections," says Lorch.

—SARAH LIGON,
STUDENT INTERN



THE PIGEON WORK ETHIC

Ever wonder why a misty glass of lemonade, clinking with ice cubes, tastes better if you have to jog a mile under the hot July sun to get it? Well, so has UK psychology professor Thomas Zentall—and he may have the answer.

Zentall found that pigeons were happier with a reward earned by tiring work than with the same reward offered after little effort.

Three years ago, he began to explore the relationship between work and reward value using White Carneaux pigeons. Each was placed in a holding box alone, faced with a single white plastic button.

During half of the trials, the button turned red after one peck and dispensed a pigeon-size serving of grain. But during the remaining trials, the pigeons pecked over and over with no response. The button had to be hit 20 times before it changed color, this time to green, and the same grain serving was offered up.

After 100 trials a day for 20 days, the pigeons were veterans at both red and green button-pecking. So Zentall gave them a third test: this time, the bird could choose either red or green. He reasoned that the pigeon would most likely opt for

red, the color that had led to the easy treat. But the pigeons picked green—the 20-peck button—twice as often as red.

Are the pigeons satisfied by hard work? Or just too stupid to identify the easier job?

Neither, Zentall suggests.

“One interpretation of this is that the pigeons are somehow evaluating the colors, thinking, ‘If I worked this hard for it, the green button must be worth more.’ The pigeon might be trying to justify the hard work by assigning the 20-peck grain extra value—a contradiction of beliefs and behavior known to social psychologists as ‘cognitive dissonance.’”

Zentall gives an example of a student who earns an “A” in both basketball and organic chemistry, but is happier with the chemistry grade because she worked harder for it. “It’s exactly the same ‘A,’” Zentall points out. “But according to cognitive dissonance theory, she has to

justify her hard work by assigning the chemistry ‘A’ a higher value.”

But Zentall believes there might be an even simpler explanation. “When you’ve worked with pigeons,” he says, “you realize that they don’t seem quite as smart as that.”

Instead, he suggests that the green button choice stems from the amount of change in the animal’s mental state from before and after it gets fed. During the red, one-peck button trial, the pigeon’s mood barely alters. “He goes from just OK to happy,” Zentall says. “But the 20-peck trial causes more discomfort. Its reward makes the pigeon change from frustrated to happy.” So the pigeon chooses green because it had the greatest effect on the pigeon’s mood. “This is a simpler explanation,” he says. “It’s more biological, put in terms of the relative state of the organism.”

This concept applies to the hypothetical chemistry student, as well. “When you take organic chemistry, and you finally

get through it, the relief is a wonderful thing. But playing basketball was already pretty fun to start with, so the ‘A’ doesn’t make you feel much better.”

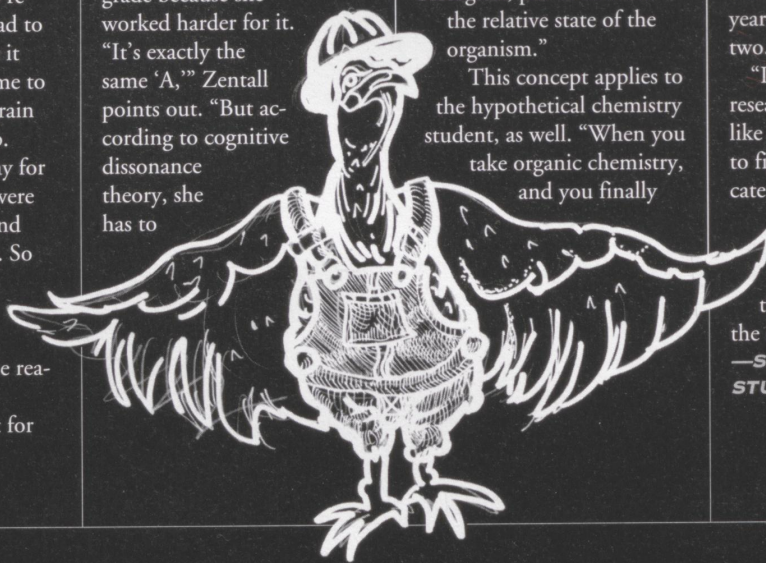
Zentall suggests that the pigeon’s shift in “relative state” may explain the human concept of work ethic. “The major reason for this research,” he explains, “is to demonstrate a kind of continuity across species—certain fundamental things that are generally true.” Zentall believes that his funding from the National Institute of Mental Health may have been awarded because of such possible connections between his research and our own behavior.

Why use pigeons to unravel mysteries of the human psyche? Zentall, who has worked with pigeons for 30 years, describes his animals as “the farmhorses of the bird family.” They’re easy-going, reliable, and live for up to 20 years as opposed to a lab rat’s two.

“I really enjoy this kind of research,” says Zentall. “It’s like solving a puzzle—you have to figure out how to communicate with an animal about

what you want him to do and then get him to answer.” He grins. “That’s the reward I get from doing the research.”

—SARAH LIGON,
STUDENT INTERN



MONARCH BUTTERFLIES IN THE NEWS

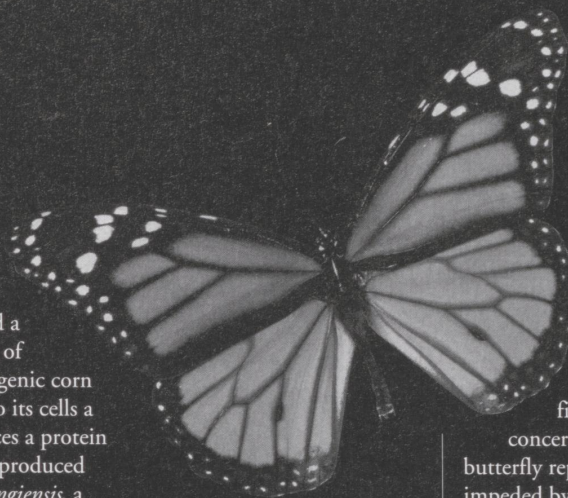
The monarch butterfly made headline news around the world in the fall of 1999, when environmental activists at the World Trade Organization's meeting in Seattle dressed as the colorful, migratory insect as part of their conspicuous protest of the growing of transgenic corn, specifically developed to fend off European corn borers, a moth especially widespread in the eastern United States. The insect's larva is a major pest in the stems and crowns of Indian corn, dahlias and potatoes. Transgenic crops are those developed to contain genetic material from another organism.

The protests were sparked by a laboratory study at Cornell University which suggested that caterpillars feeding on pollen from

transgenic corn showed stunted development and a higher incidence of death. The transgenic corn had encoded into its cells a gene that produces a protein identical to that produced by *Bacillus thuringiensis*, a naturally occurring bacterium. That protein is lethal to European corn borers.

That modest study at Cornell resulted in a flurry of research activity concerning all facets of the monarch butterfly, including its feeding and reproductive habits. UK entomologist Ken Yeaman and undergraduate student Chanda Bartholomew did a study of their own on the colorful insect.

They found that the time when the transgenic corn sheds its pollen does not coincide with the sensitive re-



production time of monarch butterflies in Kentucky. The monarch butterfly lays her eggs on the milkweed plant, which is widespread throughout the United States, sometime after the pollen is shed. Other research has shown that the chemical in the pollen shed by transgenic corn is quickly degraded by sunlight. Thus, the butterflies can lay their eggs safely as long as there is opportunity for degradation of the chemical after pollen shed.

"Our research showed that

reproduction of the insect occurs after pollen shed in corn grown in Kentucky. This finding suggests that

concern about monarch butterfly reproduction being impeded by growing transgenic corn in Kentucky is exaggerated," Yeaman says. In Kentucky, more than a quarter of a million acres of transgenic corn is grown annually.

Further, he notes, because the transgenic corn supplies its own naturally occurring pesticide against the potentially damaging corn borer, farmers use considerably less pesticide to grow their crop than if they grew conventional varieties of corn.

—RANDY WECKMAN,
COLLEGE OF AGRICULTURE

DETECTING PCBs

The issue of PCBs, polychlorinated biphenyls, is widely known. Improper disposal of industrial waste and common household items like old paint, rubber, plastic, refrigerators, and washing machines have allowed PCBs to enter our soil and water supplies.

PCBs are suspected of causing a slew of reproductive, neurologic and immune disorders in animals and people. They are particularly troublesome because they tend to remain in

soil and water for a long time, and they move from these elements into fish and, ultimately, people at the end of the food chain. Kentuckians are currently warned by the Department of Water to restrict their consumption of fish from several local rivers and lakes, including the entire length of the Ohio River and portions of the Mud River, Drakes Creek and Green River Lake, because of PCB contamination in the flesh of fish.

Wide-scale field sampling

and laboratory testing of soil for contamination using current technologies are almost insurmountable tasks. Elisa D'Angelo, an assistant professor of agronomy at the University of Kentucky, is testing the use of biosensors—genetically engineered microorganisms that can detect even low levels of PCBs in soil and water samples. (These biosensors were developed by Sylvia Daunert in the UK Department of Chemistry.) The biosensors D'Angelo is using are genetically engineered bac-

teria that glow when exposed to PCBs.

"The microorganisms glow when PCBs are present and glow even brighter as the concentration increases. With this technology, we can survey a large number of soil and water samples quickly and inexpensively, which should allow us to notify the public of potential health risks in water supplies and in soils," D'Angelo says.

—RANDY WECKMAN,
COLLEGE OF AGRICULTURE

OPTIMISM A STRONG ALLY FOR IMMUNE SYSTEM

"Whistle while you work."
"Look for the silver lining."

They're age-old bits of folk wisdom, but as sound medical advice we tend to dismiss these sayings along with "an apple a day."

However, recent studies of optimists under stress by UK psychologist Suzanne Segerstrom have shown that you may indeed stay healthier if you think the glass is half full.

Segerstrom's interest in optimism's effects on health began while she was a graduate student at UCLA, working on a study of men infected with HIV. "I started out looking at outcomes like emotional and social adjustment," she says, "but in the process I became interested in whether these same factors were also predicting immune system changes."

To explore the effects of positive outlook on the immune system, Segerstrom then studied the 1997 batch of first-year law students at UCLA—a group guaranteed to be under relatively high stress.

Segerstrom began by surveying the students for two main types of optimism: "dispositional" optimists, who had more generalized positive beliefs about the future, and "situational" optimists, people who had specific positive beliefs about their upcoming law school experience. The survey asked students to agree or disagree with such

phrases as, "In uncertain times I expect the best," or "It's unlikely that I will fail." Once characterized as more optimistic or pessimistic, the students had blood drawn: once before starting school, and again at mid-semester.

"Before they started law school," says Segerstrom, "there was absolutely no difference in the optimists' and pessimists' immune systems." However, as the semester progressed and the coursework piled higher, Segerstrom's pessimists began to lag.

By midterm, the optimists had higher numbers than pessimists of cells that protect the immune system against disease. Segerstrom repeated the tests in 1998, this time on UK's first-year law students, and got similar results. At UK midterm, 67 percent of pessimists but only 29 percent of optimists tested "clinically inadequate," indicating the partial failure of their immune system.

This doesn't mean that 67 percent of pessimists were actually sick. "You can change quite a bit and still be within normal parameters for a healthy person," says Segerstrom. And many symptoms of such classic fall-semester bugs as influenza or the common cold are actually caused by the immune system itself, generating heat and sap-

ping energy levels as it fights germs. "So it's possible that if you're anergic, you just won't feel as sick," she says. "Your immune system might not respond as strongly."

The significance lies in the change under stress. "It's not like pessimists are walking around sick all the time," Segerstrom points out. "What optimism really does is buffer you against stress."

With the help of UK undergraduates, research interns, and graduate students, she is trying to discover the secret behind optimists' stress management. "It seems there's something else going on with them," says Segerstrom. "Studies have shown that things such as amounts of sleep and alcohol intake don't explain the immune system differences."

Whether pessimists can be transformed into optimists, then, is still unclear.

"It may be more fruitful," she says, "to get people to employ certain cognitive strategies—get them to think positively—rather than try to change their personalities."

—SARAH LIGON,
STUDENT INTERN

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PARTING SHOTS

"Obstacles are those frightful things you see when you take your eyes off your goal."

—Henry Ford (1863-1947)

"The best way out is always through."

—Robert Frost (1874-1963)

"Fall seven times, stand up eight."

—Japanese proverb

"Never mistake motion for action."

—Ernest Hemingway (1899-1961)

"The whole world steps aside for the man who knows where he is going."

—Anon

"We are confronted with insurmountable opportunities."

—Pogo

"There are many ways of going forward, but only one way of standing still."

—Franklin D. Roosevelt (1882-1945)

"Problems are only opportunities in work clothes."

—Henry Kaiser (1882-1967)

"Without a struggle, there can be no progress."

—Frederick Douglass (1817-1895)

"Never believe that a few caring people can't change the world. For, indeed, that's all who ever have."

—Margaret Mead (1901-1978)

"To change and to change for the better are two different things."

—German proverb

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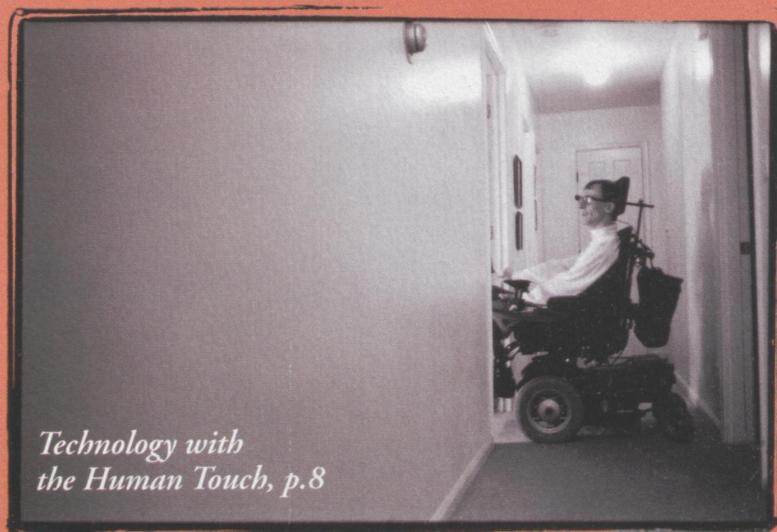
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*Technology with
the Human Touch, p.8*

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