

ODYSSEY

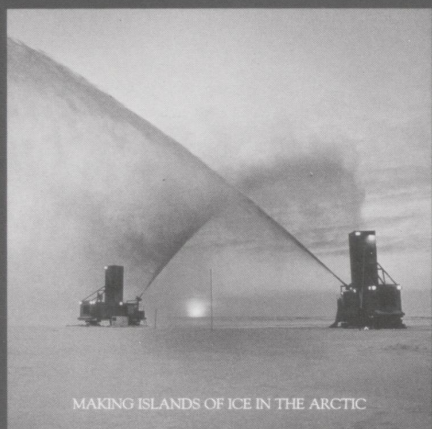
WINTER • A MAGAZINE OF UNIVERSITY OF KENTUCKY RESEARCH • 1988



MAKING ISLANDS OF ICE IN THE ARCTIC

ODYSSEY

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MAKING ISLANDS OF ICE IN THE ARCTIC

The University of Kentucky, the Commonwealth's graduate education and research institution, exists to provide opportunities for the education, personal growth and development of individuals and to contribute to the improvement of society.

With this mission as its premise, one goal of the University is to conduct programs of basic and applied research which support graduate and professional education, provide for the advancement of knowledge, and seek solutions to the acute problems of society.

The University's research mission also acts as a magnet for attracting top graduate students who want to participate in nationally competitive research projects. This research experience can offer them a significant advantage in their education while laying the foundation for future research and development. **ODYSSEY Magazine**, through articles about various research projects and graduate education programs, reflects the breadth of the University's search for new knowledge and the myriad of research endeavors underway. The progress that the University has made toward achieving its research mission and securing the extramural funds required to support these types of endeavors would have been impossible without the talents and dedication of our researchers.

The goal of **ODYSSEY Magazine** is to offer the reader the opportunity to share in some of the excitement, curiosity and creativity evident in the research underway at the University of Kentucky.

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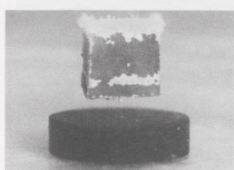
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Cover: The genesis of Mars Island: At temperatures averaging below -20°C , pump units spray seawater 200 feet into the air, where the water droplets freeze to form ice crystals. Photograph courtesy of the Amoco Corporation. Article on page 2.

Printed Jan., 1988



MAKING ISLANDS OF ICE IN THE ARCTIC

UK Mathematician Helps
Determine Life-Span of
Man-Made Islands

by Jeff Worley

The Amoco engineer walked across the thick ice and looked into Harrison Bay, Alaska. Mid-October and already -15 C. Large chunks of sea ice, ice rubble, drifted out into the Beaufort Sea.

The engineer had a problem: Which traditional building material would be best suited—and most economical—to construct a drilling platform for exploration five miles offshore. Gravel? Steel? Concrete? The solution, it turned out, was as obvious as the crunching sound of the man's boot steps.

Ice.

The idea for Mars Island, the first sprayed-ice island used as a drilling platform, was born.

In early January of 1986 engineers began flooding the ice pack five miles northeast of Cape Halkett to a thickness of four feet to support ice-spraying equipment. At temperatures averaging below -20°C , seawater was then pumped from beneath the ice sheet and sprayed 200 feet into the air, where the water droplets froze to form ice crystals.

As the spraying continued, a mass was built up that depressed the ice sheet until it grounded on the seabed. Four pump units worked around the clock, logging 892 hours of pumping time and spraying 266,000,000 gallons of seawater in 46 days. The result was Mars Island, 50-feet thick—half of this mass below sea level—and 950 feet in diameter.

The hard stable island surface supported the drilling equipment and 60 workers. Oil exploration began in February and continued until mid-April when the island started to break up; by mid-July the island had melted.

In the construction of these man-made drilling platforms, a major engineering concern has been the creep settlement of the ice islands. Since ice deforms, or creeps, continuously even under a fixed load, an ice island constantly moves downward during its working life because of its own weight and the load it supports.

The engineering problem of creep settlement has intrigued Dr. Chi-Sing Man, an assistant professor of mathematics at the University of Kentucky, who became interested in rheology, the science dealing with deformation and flow of matter, during his studies ten years ago at Johns Hopkins University. Man, a native of Hong Kong who holds advanced degrees in mechanics and mathematics, is currently working on the problem of creep settlement of the sprayed-ice islands.

"Because of the short working life of an ice island (approximately two months) and the relatively consistent level of stress on the island—the weight of the men and equipment, and the fairly uniform weather conditions—it seems likely that the main cause of settlement is primary creep of ice," says Man. "Primary," he explains, refers to the initial period of decelerating creep.

Man is currently at work on two new constitutive equations, models which describe the material and are independent of the geometric configurations, for the primary and secondary

creep of ice. His objective is to study and compare the mathematical properties exhibited by these two models in some typical flow problems.

"To a rheologist any object that deforms 'flows'; even rock flows if looked at in geological time," Man says. "This study will reveal whether my equations have reasonable flow properties and will provide information for discovering which of the two is the better model."

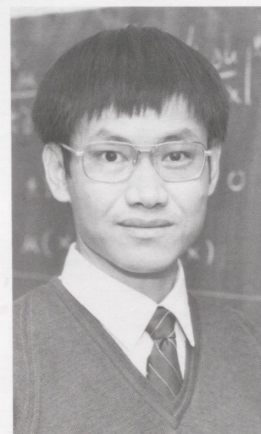
Man's equations are based on creep characteristics of ice which are determined by field tests and laboratory experiments. In the laboratory a triaxial creep test, for example, measures the shortening of a sample of ice under pressure. A bar of ice, three to five inches long, is enclosed by a latex membrane and inserted into a bath of hydraulic fluid in a cylinder made of Perspex, a hard transparent material. Because the sample must be kept at a temperature below freezing, a fluid such as kerosene or silicone whose freezing point is substantially lower than the testing temperature must be used. The ice is compressed by a piston-like stainless steel ram so that researchers can determine how ice behaves under different stress levels.

The pressures exerted on the ice in a triaxial experiment are roughly analogous to those exerted on man-made ice-islands. The lateral force of the fluid used in the laboratory test is similar to the stress caused by Arctic sea water; the downward pressure applied to the ice sample corresponds to the pressure of the drilling equipment and men on the island.

"Unfortunately, there's a problem with treating the lab specimen as if it were the ice island," Man admits. "For an ice island in the Arctic, there is a substantial change in temperature within the ice of the island. For instance, at the top of the island, which is exposed to the Arctic air, the mean temperature will be about -30°C ; at the bottom, which sits on the sea floor, the temperature will be about -2°C ."

Man is supplementing information gathered from triaxial experiments with data collected from pressuremeter tests. This procedure involves boring a hole into the sprayed ice and then easing a measuring cell down to various depths in order to determine the creep behavior of the ice at different points. The testing

Four pump units worked around the clock, logging 892 hours of pumping time and spraying 266,000,000 gallons of seawater over 46 days. The result was Mars Island.



Chi-Sing Man, Mathematics

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Mars Island was constructed five miles northeast of Cape Halkett (magnified area).

A third source of data comes from field settlement observations. Amoco engineers working on Mars Island monitored rig settlements and overall island settlement throughout the working life of the island.

In discussing the effectiveness of sprayed-ice islands, Dr. R.D. Goff, frontier technology manager for Standard Oil, states that spray ice has successfully demonstrated its usefulness as an offshore drilling structure. "However, more material creep data is required. Creep behavior and performance is currently interpreted from field and laboratory data and not by constitutive equations and numerical analysis," Goff says.

comprehensive enough. Man explains that "Glen's flow law is not adequate for the problems faced by these engineers because it can describe only secondary creep, the stage of almost steady creep which comes after the initial decelerating stage. The rate of primary creep, on the other hand, is important since the working life of the island is so short that secondary creep may not be attained."

When his studies are completed, the mathematical theorems, theoretical developments and general conclusions will be published. As for the specific findings which pertain to Mars Island, Man will send his results to the University of Manitoba, where he is involved in collaborative research. Petroleum companies such as Amoco will then be able to use Man's equations when the next sprayed-ice island is built.

FIDO'S FOOD: A New Weapon Against Heart Disease

Whenever Dr. James Anderson, chief of endocrinology, sees a cat or dog, he feels a little guilty. Although his research on nutrition has meant tremendous progress toward understanding and controlling cardiovascular disease, it has also forever changed what these pets are fed.

Anderson has been studying the effect of fiber on serum cholesterol levels—the primary risk factor for cardiovascular disease (CVD)—since the mid-1970s. Knowing that oatmeal effectively lowers serum cholesterol levels, Anderson decided to test oat bran on himself. However, he soon discovered he couldn't find it in any grocery stores. So he called the Quaker Oats Company and was told that oat bran wasn't available there either. Not satisfied with that answer, Anderson called back.

"I said, 'You've got to know something!'" says Anderson. "They checked again and informed me that oat bran was a by-product of milling oats and that it was being put into pet food.

"They reluctantly agreed to send me a 100-pound drum."

That year, 1977, Anderson says he "got religion" and began supplementing his diet with the oat bran. Anderson knew his blood cholesterol level was 285 milligrams per deciliter (mg/dl), a dangerous level inherited from his mother, but had done nothing about it. After five weeks of eating 100 grams of oat bran a day, Anderson found his cholesterol dropped to 175 mg/dl. In 1981, Anderson published his first paper on his oat bran findings; Quaker Oats had a new product and pets no longer had oat bran in their food.

"There is a lot of competition now between manufacturers of oat bran," says Anderson. "Millions of people are eating it. Recently, Quaker Oats has saturated the print media about reasons to eat oat flour and bran. One reason they list is that it lowers blood cholesterol.

"Our work is what really got them into this. Now, though, when I see a cat or dog, I feel a little guilty, because they're not getting their oat bran anymore. Now that bran is so popular, the Quaker Oats company obviously finds it more profitable to sell bran to humans at \$1.30 a box."

From a human perspective, the animals' sacrifice is worth it. Anderson's work has been so



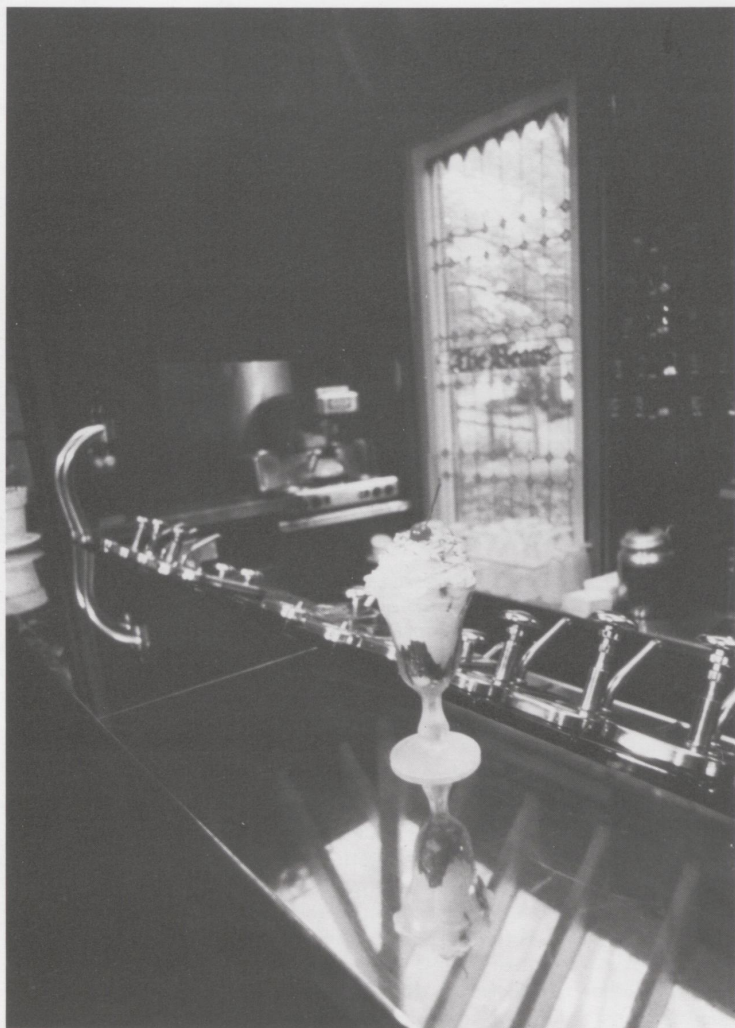
Anderson's research has established oat bran as an effective weapon against cholesterol build-up. As a result of Anderson's findings, the Quaker Oats Company began to manufacture a new product.

successful that UK was one of five schools nationwide to receive a \$959,000 multi-year grant from the National Institutes of Health (the universities of Alabama, Oregon, Harvard, and Vanderbilt also received funding). With the additional support of \$50,000 from other sources, such as the Quaker Oats Company, four UK principal investigators are exploring different aspects of the fiber-CVD question: Drs. Anderson and Gordon Guthrie, medicine/endocrinology; Geza Bruckner, clinical nutrition; and Thomas Garrity, behavioral science.

It is research that will affect millions of people. Cardiovascular disease is the number one cause of death in Kentucky and the nation. Every year nearly 1,000,000 Americans die from CVD at an estimated cost of \$83 billion. In Kentucky, it will be responsible for the death of about 49 percent of those who die this year. Another six million Americans suffer from symptoms of the disease, such as chest pain, angina, and shortness of breath when walking too fast.

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The temptation



Just over a year into their projects, the professors are specifically researching the role of fiber on different risks of CVD. The principal project, a three-year study, is comparing the effects on serum lipid levels of two diets that are similar except that one calls for substantially more fiber. The other three projects, all two-year studies, examine fiber's role in reducing cholesterol levels and in treating hyperten-

sion, and fiber's effect in combination with fish oil on several risk factors of CVD.

The studies are large, involving a number of UK people. Working with the four principal investigators are five UK professors: Norman Gilinsky, medicine; Ralph Miller, medicine; Daniel R. Richardson, physiology and biophysics; Harlley McKean, statistics; and Peter Oeltgen, pathology. Approximately 50 others, including nurses, registered dietitians, graduate students and various coordinators, are also part of the team.

Two Diets Put to the Test

Cardiovascular disease is a complex problem influenced by a number of factors including smoking, hypertension, obesity, and familial history of CVD. However, scientists agree that the underlying process of CVD is atherosclerosis, or hardening of the arteries. Through this process, plaques of lipids, cholesterol and scar tissue are deposited on the artery walls. Gradually they become more narrow until a blockage results and there is death of tissue. Because cholesterol is the predominant element in plaques, the leading risk factor for CVD is excessive levels of cholesterol.

Studying the effect of two diets on serum lipid levels, particularly cholesterol amounts, is the aim of the principal part of the project. Directed by Drs. Anderson and Garrity, the three-year study is comparing the American Heart Association's diet, the one most widely recommended to patients with heart disease, to a high-carbohydrate, high-fiber (HCF) diet created by Anderson.

According to Anderson, there are about 20-30 million Americans trying to follow the AHA diet, which is very similar to his diet. Both recommend that people obtain 55 percent of their day's calories from carbohydrates, 25 percent from fat, and 20 percent from protein, while consuming no more than 200 milligrams of cholesterol per 2000 calories. The only difference is in the amount of fiber recommended: the AHA diet suggests 15 grams per 2000 calories while the HCF regime calls for 50 grams. (Two oat bran muffins would provide about nine grams of fiber).

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Going After Hypertension With Fiber

In addition to cholesterol, high blood pressure is considered a major risk factor for CVD. Not only does it cause additional stress to the arteries and heart, high blood pressure also contributes to the build-up of the deposits of plaques on the arteries.

Hypertension affects over 60 million people. Extremely elevated levels can cause kidney and heart failure and cerebral hemorrhage from the bursting of arteries. People who are mildly hypertensive have twice the risk of having a stroke or heart attack than those who have normal blood pressure.

"There are some theories about the effect of hypertension on CVD," says Dr. Guthrie. "But no one is sure of the exact mechanism."

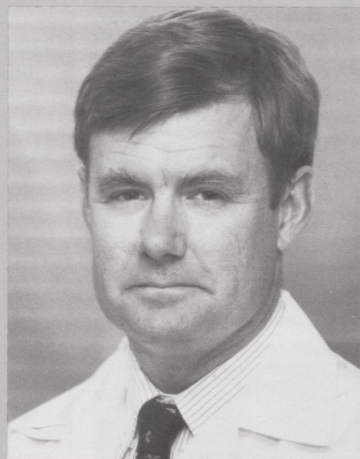
Guthrie's project is examining ways to reduce hypertension with dietary fiber. In particular, he is watching the influence of fiber on insulin and insulin's effect on blood pressure.

"A high-fiber diet seems to lower a person's blood pressure," says Guthrie. "The hypothesis, a relatively new one, is that it does this through its effect on insulin."

Produced and stored in the pancreas, the hormone insulin is released when high glucose levels are present in the blood. Its major function is to metabolize glucose by enabling many cells to absorb it.

Insulin also promotes the synthesis of proteins and the synthesis and breakdown of triglycerides in fat. Another function of insulin is to allow the body to retain salt and, thus, water as the insulin circulates through the kidneys.

"Studies have demonstrated that insulin is a potent sodium-retaining hormone in the kidney," says Guthrie. "The relationship between sodium and hypertension is an intimate one. Many scientists feel that of the people who have high blood pressure, one out of four or five are salt sensitive. This means that if they restrict



Gordon Guthrie, Medicine/Endocrinology

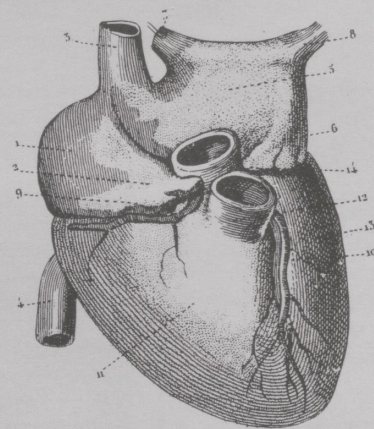
their salt intake, there's a lowering of their blood pressure."

Fiber's role in this mechanism is one of improving the body's sensitivity to insulin. According to Anderson, his high-carbohydrate, high-fiber diet enables two-thirds of his patients with adult-onset diabetes to stop their insulin shots. Their bodies have become sensitive enough to their own levels of insulin to eliminate the need for more.

Guthrie's hypothesis is that while fiber enables the body's tissues to survive with less insulin, the kidney does not respond this way. The proportion of salt retained by the kidney is still in direct ratio to the amount of insulin present. Thus, fiber means that less insulin is needed for glucose absorption; if lower levels of the hormone are present in the blood, less sodium is retained in the kidney.

Guthrie says that lower levels of insulin have a second effect: less insulin means less blood vessel constriction, a condition which is also a factor in high blood pressure.

To determine the influence of fiber on hypertension, 20 men and women, ages 21-60 and considered mildly hypertensive, are adhering to both



the HCF (Anderson's) and the AHA (American Heart Association's) diets for two months. Similar in composition, the diets differ only in the amounts of fiber prescribed; the AHA suggests 15 grams while the HCF provides 50 grams.

Before starting the diet program, the participants are being monitored for one month. Every two weeks, they have a blood pressure test. These baseline measurements will be used for comparison purposes.

Because changes in blood pressure are typically slow and subtle, Guthrie is monitoring the participants' blood pressure in two ways. First, after starting on the diets, they have a check-up every two weeks. Second, at the end of the second month of following the diets, the participants will stay for three days in the Clinical Research Center, a metabolic ward at the University Medical Center. While there, each will have a 24-hour blood pressure profile compiled, with readings taken every 15 minutes.

Blood pressure goes through a fairly wide range of changes during the day, says Guthrie. "It's low when one sleeps and rises during meals and certain activities. The 24-hour profile will enable us to see if it's lower round-the-clock."

Additional tests are also made so that the researchers have a complete profile on each patient. "We're trying to look at all aspects of blood pressure," says Guthrie. "This will be information for a later study." ■

However, that one variation is the reason for the differences in effectiveness. According to Anderson, available data indicate the AHA type diet lowered serum cholesterol concentrations at the most by 7.4 percent, reducing risk for CVD by less than 20 percent. In contrast, preliminary studies by Anderson and other researchers indicate that nutrition intervention with diets generous in dietary fiber lowered serum cholesterol by 15-20 percent with a risk reduction of about 40 percent.

"Our research is persuasive," says Anderson. "However, it's not to the point where there are enough data to persuade the AHA, which is a very conservative group. This match-up is what intrigued the NIH and the reason they gave us the money. I think the study will show that the high-fiber diet is clearly more effective than the one from the AHA."

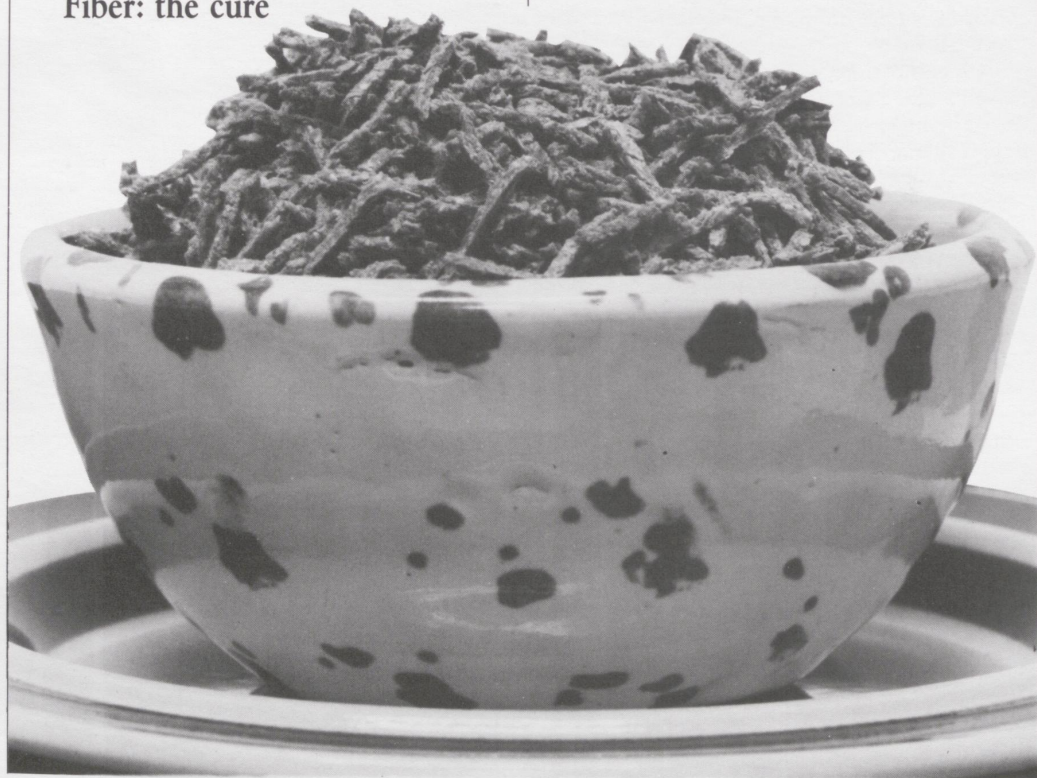
Testing the diets are 180 men and women, ages 30-50, from Lexington and the surrounding area. Randomly separated into three groups of 60, these participants are basically healthy, except for elevated levels of cholesterol—between 200-300 milligrams per deciliter. This range is considered undesirable, but not serious enough to require immediate drug intervention.

For two years, the participants are eating a prescribed diet. One group is following the AHA diet, one the HCF, and one is consuming whatever they want. This last group is functioning as a control factor for the purposes of comparing results.

A Change in Attitude

One such participant is Tony Burgett, 42, an RN at the Veterans Administration hospital. In the AHA group, Burgett has been following the diet since May. For him, the

Fiber: the cure



decision to participate and commit that much time was easy: It could save his life.

"My father and all his brothers and sisters have real bad heart disease," says Burgett. "I knew there was a strong genetic possibility for my having heart problems."

This is the first time Burgett has ever done anything about his possible heart disease problem. Tested for cholesterol and other lipid levels about four years ago, Burgett was told he had normal levels. However, when tested for this project, Burgett found his cholesterol was at 264 milligrams per deciliter, a range considered undesirably high. This test result concerned him because Burgett knew that higher levels of cholesterol means higher risk for heart disease. His experience as a health care professional made him aware of the long-term effects of an unhealthy diet.

Yet, like many other people, Burgett experienced no symptoms of heart disease, nor had any major illnesses or health problems. According to him that's one reason why it's difficult to be persuaded about the seriousness of high cholesterol levels.

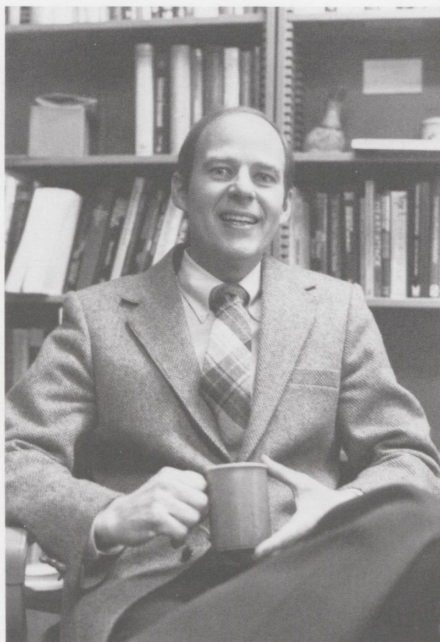
"Often times, the thinking is that I don't feel bad so I'm not sick," says Burgett. "It's hard realizing that the best way to fight this is not by taking pills but by not eating certain foods, foods that I love."

For Burgett, this meant giving up fried foods, snacks like ice cream and chocolate, and most dairy products, including his all-time favorite eggs benedict.

"I *love* eggs benedict, but it's like eating nothing but a big bowl of cholesterol," says Burgett. "They're so bad for you."

Other changes for Burgett include thinking about where he can go out to eat instead of just going on the spur of the moment, something he's likely to do since he's typically very busy. In fact, his entire attitude toward food has changed. Now he closely reads labels and checks ingredients of foods. One principle he follows is that the more easily a food can be

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Thomas Garrity, Behavioral Science



consumed, except for eating something raw, the more likely it has lots of fat and sugar in it. For Burgett, this includes fast foods, doughnuts, soft drinks, and various other snacks.

"Food can't be a casual thing," says Burgett. "I've had to change completely. I grew up in Kansas where you ate eggs and drank a big glass of whole milk before you did anything."

One Day at a Time

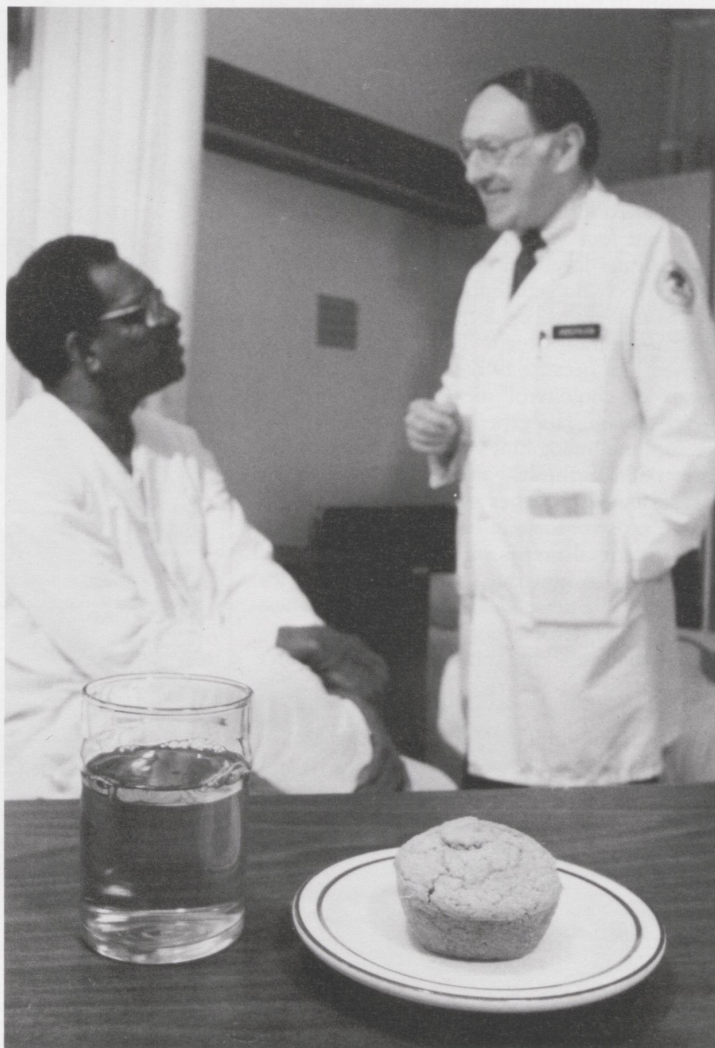
To help Burgett and the other participants in the AHA and HCF groups to understand ways to modify their diets, they went through a ten-week education course started last May. Taught for one hour a week, the training emphasized the practical matter of how to follow the diets rather than any theoretical considerations about cardiovascular disease. The participants learned to read labels on food packages, distinguish between the types of fats and to cook with low-fat methods. They also received instruction on ways to add fiber to their diet, to eat healthy meals at restaurants, and to keep a record of what they consume.

Also during the ten weeks, the group attended small biweekly meetings to do exercises that tested their understanding of the lectures and to check their blood cholesterol levels. In addition, the participants met individually with a dietician for 30 minutes each week to set dietary goals and discuss ways to achieve them.

Sticking with a new diet isn't easy, no matter how motivated you are, admits Burgett. He says he's done pretty well but has eaten eggs benedict and some other things he knows better than to eat. For him, one problem is his working environment.

"There are so many things that clutter up your diet, like birthdays," says Burgett. "Where I work, there are lots of them which means cakes, ice cream, doughnuts—lots of cholesterol, fats, etc. Someone will say 'Oh here, have some,' and the next thing I know I'm eating it and then I remember that what I'm eating is basically lard."

This problem with dietary change is one that Garrity confirms and the reason he developed the education program. High compliance



Dr. Anderson talks with Rev. Walter Taylor, one of the participants in a study to determine the effect of fiber on bile acid concentration.

The Complex Story Of CVD

Cardiovascular disease is usually associated with heart attacks. However, CVD also causes strokes and peripheral vascular disease. The major underlying cause of CVD is atherosclerosis, or hardening of the arteries.

Atherosclerosis is marked by lesions formed by plaque deposits on large and small arteries. These plaques are made up of scar tissue, cholesterol, triglycerides, and other lipids. As the disease progresses, the arteries become rigid and narrow, ultimately causing a blockage. Because cholesterol is the dominant element in plaques, high cholesterol level in the blood is considered the leading risk factor for CVD.

Despite all the negative connotations associated with cholesterol, it is an important element in the body. All cell membranes contain cholesterol. Also, bile acids and several hormones—testosterone, progesterone, estrogen, among others—are made from it. However, although necessary for proper functioning, cholesterol does not need to be consumed because the liver manufactures all that a person needs.

Excessive cholesterol is not an unexpected result for those eating a typical western-world diet. Although cholesterol is found only in meat and dairy products, Americans consume a lot of these foods; the typical western diet provides, each day, 450 milligrams of cholesterol and only 10-15 grams of fiber. With this diet a person gets 39 percent of a day's calories from fat, 43 percent from carbohydrates, and 18 percent from protein.

In contrast, experts suggest getting no more than 200 milligrams of cholesterol a day with 55 percent of the calories from carbohydrates, 25 percent from fat, 20 percent from protein and 15-50 grams of fiber per 2000 calories.

Excessive cholesterol, however, is not the only known risk for CVD; in fact, CVD is a complex problem that is influenced by a number of factors. In addition to cholesterol, smoking and hypertension are the two other leading risks associated with the disease. Other known factors are family history of heart disease, obesity, diabetes, a sedentary lifestyle and high levels of triglycerides, a type of fat. While this list is long and likely to grow longer with additional research, all of the factors, except smoking, family history and a lack of exercise, are directly influenced by dietary habits.

is essential for the researchers to study the effectiveness of the diets. Because the participants are at home, not in an environment controlled by the researchers, the results are reflective only of how well the group follow their diet. Thus, a second important aim of this study is determining whether an equally high level of dietary compliance can be achieved by the HCF and AHA diets. This task won't be easy because the long-term following of a preventative or therapeutic regimen is notoriously poor.

"For the last thirty years in medical behavioral research literature, all sorts of compliance has been looked at," says Garrity. "For long-term, difficult dietary changes, compliance has been as low as 25 percent. To address this, we've incorporated a number of supports for the patients. We've tried to set it up to give the two diets the best possible chance to succeed."

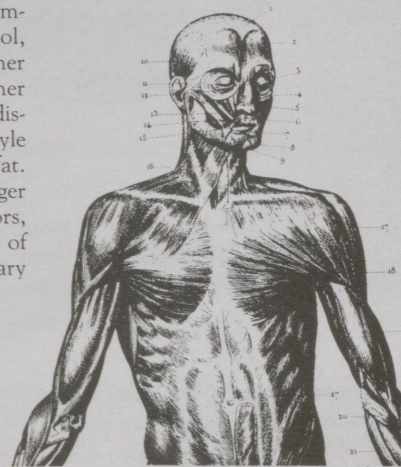
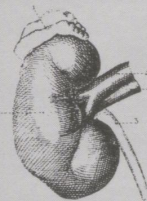
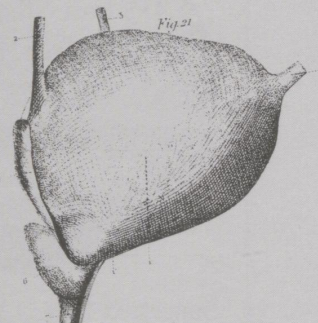
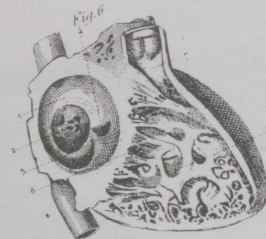
The payoff for Burgett has been quick and encouraging. Like all the participants in the HCF and AHA groups, Burgett is having his cholesterol and other lipids measured again several times during the study. His first re-measurement showed a new cholesterol level of 215 mg.

"It's gotten easier with time," says Burgett. "It becomes like second nature. The philosophy I've adopted is one day at a time. You can't step out too far and say I will do this forever because then you're only setting yourself up to disappoint yourself. Some days it's hard to stick with the diet but I know this and I try to control myself."

In addition to monitoring the changes in the patients' cholesterol levels, Anderson and Garrity are also looking at other aspects of the serum lipids. The UK professors are watching the ratios of the various lipoproteins, the protein packages made in the liver to transport cholesterol and other lipids.

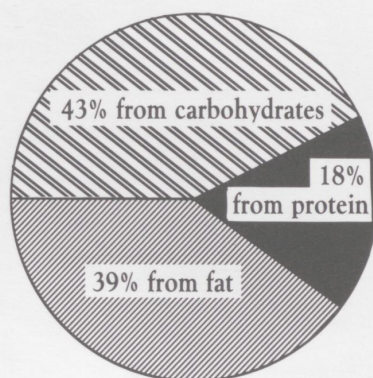
"It's conceivable that the total cholesterol levels won't change, but rather there will be a shift in the distribution and ratio of blood fats," says Garrity. ■

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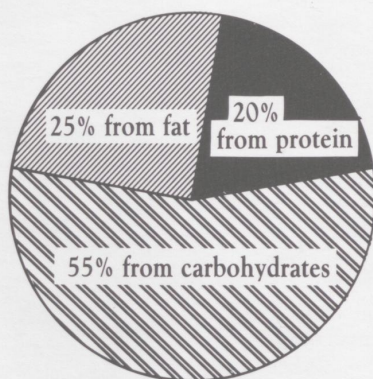
Typical Western-World Diet

450 milligrams of cholesterol
10-15 grams of fiber



Suggested Diet

200 milligrams of cholesterol
15-50 grams of fiber/per
2000 calories



Desirable Values for CVD-Risk Factors

- ☐ Blood pressure — no more than 140/90 (Systolic/Diastolic).
- ☐ Cholesterol — 140 + your age (less than 200). (In milligrams per deciliter).
- ☐ High-Density Lipoproteins — 30-70.
- ☐ Low-Density Lipoproteins — 40-160.
- ☐ Triglycerides — 40-160.

Sample Menus for the HCF Diet

These menus provide 2000 calories with 55% from carbohydrates, 25% from fat, 20% from protein, and less than 200 milligrams of cholesterol. Each menu also includes 50 grams of fiber.

Breakfast

- 1/2 cup skim milk
- 3/4 cup oatmeal
- 2 oat bran muffins
- 2 tsp. margarine

Lunch

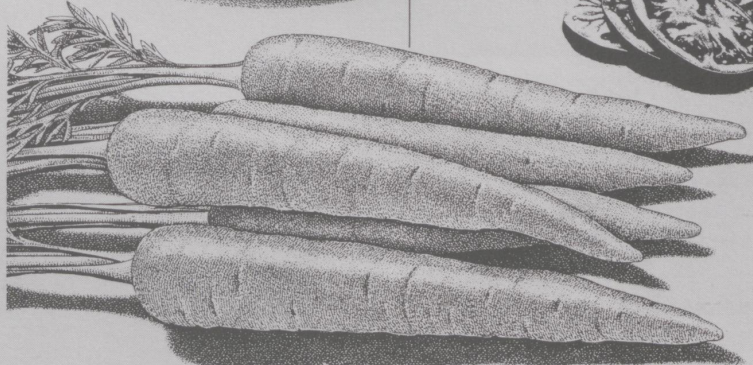
- 2-3 ozs. charbroiled chicken
- 2 slices whole wheat bread
- 2 tsp. mayonnaise
- Lettuce and tomato
- Garden salad (lettuce & 1/2 cup vegetables)
- 4 tsp. French dressing
- Raw apple
- 6 almonds

Supper

- Cottage cheese/pineapple salad (1/4 cup cc & 1/2 p)
- Kidney bean lasagna (3x4 sq. piece)
- Broccoli/cauliflower medley (1/4 cup of each veggie)
- 1/2 cup baked carrots
- Whole wheat roll
- 2 tsp. margarine

Snack

- 1/3 cup all bran cereal
- 1 cup skim milk
- 3/4 cup blueberries



ADVANCING BY DEGREES

Students Share Passion for Learning

Over 3400 people are participating in a unique, demanding, and enlightening experience—advanced study at the University of Kentucky. They are graduate students engaged in research and the study of topics ranging from Alzheimer's Disease to earthquakes to Supreme Court decisions.

Their reasons for pursuing an advanced degree are as varied as their backgrounds and their goals. A few had no plans to go to graduate school, let alone to carry out research. Others, even as children, developed their career plans and still others came to graduate school after developing as teachers a deep love of a subject and a fascination with inquiry. Their various experiences and interests have led them, circuitously many times, to advanced study at UK.

The following pages focus on nine of these students. Their routes to the University of Kentucky are varied—Carroll Teater, for instance, did not intend to ever be back in a classroom after a bad experience in high school. He now is a doctoral student in biochemistry and recipient of the prestigious Markey Cancer fellowship. A different route was taken by Brenda Logan Cappuccio, who had long been fascinated with the “castles and knights” of Spain. She taught Spanish and

raised her family before returning for a doctorate in Spanish literature.

The common trait that links their diverse backgrounds is a profound interest in learning. Some, in their role as graduate assistants in research, have already contributed new knowledge. Mike Townsend, for example, has manufactured and freeze-dried a product that is now used in clinical trials in pharmaceutical research.

Others are like doctoral student Yu-Ru (Paul) Kou, who demonstrates his passion for learning through pursuing not only required research but also additional studies in his area of physiology and biophysics.

Their guides are many of the top faculty researchers at the University of Kentucky. These faculty are the magnets that attract such students to UK. The best students want to learn from those at the forefront of their field because that is where these students intend to be. And such research experience gives the student a distinct advantage in achieving that goal.

What motivates a student to be in the lab at 4:30 a.m. or take only five days off during an entire summer? The students themselves explain that best.

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by Lissa D. Atkins



Bob Adams: Chemical Engineering

Sometimes chemical engineering graduate student Bob Adams can be found in his lab at 4:30 a.m.

"I just have this great idea and I get up and go on in," says Adams.

Flexible hours are one aspect this Princeton, Kentucky native likes about his research. In his second year of graduate school, Adams, 24, is studying synthetic membranes and the process of selective separation at low pressures, an area he says is relatively new. His research is supported by the National Science Foundation through the UK Center for Membrane Sciences.

"There's been a lot of research on complete removal of components with membranes," says Adams. "My work involves using membranes to remove only desired components from a mixture."

A good example of this separating ability of membranes is found in the human body. Cell walls are membranes that selectively permit certain particles in and out.

Using several commercial mem-

branes, Adams is testing their separating abilities with solute mixtures that are made synthetically. A computer program, developed by previous graduate students, will be used to mathematically model the system.

Adams anticipates numerous uses for research in this field, especially in the pharmaceutical industry. The making of pharmaceuticals often involves an expensive process where a desired component is removed from a larger mixture. Many reactants, such as enzymes, cannot tolerate high pressures or harsh conditions. With research like Adams', membranes can provide a less expensive separating process.

Presently, he is building the appropriate equipment for testing the membranes. Adams says that figuring out and purchasing the components he needs, programming the computer, and working on the electrical connections have not been difficult but have been a lot of fun. According to his advisor, Dibakar Bhattacharyya, Adams' approach to the project is one of his strong points.

"Bob is extremely good in research," says Dr. Bhattacharyya. "He's innovative and just has a good way of handling complex problems."

Adams says he's been fascinated with synthetic membranes since he learned about them as a UK undergraduate. After he gets his masters degree in the spring of 1988, he is not sure if he'll pursue a doctorate. Calling graduate research "a nice interlude between school and the working world," Adams wants to see what job opportunities will be available. His preference would be to work for a pharmaceutical company.

"I'd like to see the practical use of my work," says Adams.



Mary Cooper: Nursing

Mary Cooper has dreamed of becoming a nurse since she was a child.

"I was always intrigued by it," says Cooper. "I never thought of anything else."

Now as one of 12 students in the first nursing doctoral program at UK (and the first in Kentucky), Cooper, 28, finds she really doesn't have time to think of anything else. Her busy schedule includes 20 hours a week of teaching, 14 hours a week in class, and 6 to 8 hours a day studying.

"I feel a real sense of accomplishment after I finish a semester of school," says Cooper.

In her third semester of graduate work, this Louisville native plans to study the nutritional status of patients who are mechanically ventilated. This dissertation idea was a problem she recognized while working on her masters thesis at the University of North Carolina at Chapel Hill.

A mechanically ventilated patient has some kind of respiratory difficul-

ty, such as from a chest wound, pneumonia, or chronic lung disease. To help the patient breathe, a tube is stuck down the trachea and into the lungs. Through this tube, oxygen is blown by a ventilator at a preset rate. Depending on the problem, a patient may be ventilated for several days to several months.

With the tube in the throat, the patient can't eat normally and must be fed either intravenously or through a tube in the stomach. However, these methods have inherent risks. Intravenous feedings are high in glucose, a medium in which bacteria thrive; mechanical difficulties or patient intolerances to the food are two possible problems resulting from this treatment.

"We're looking at the best ways to feed them given their specific problem," says Cooper.

Working with mechanically ventilated patients means being in an intensive care unit (ICU), a place where Cooper hasn't always been comfortable. She says it took working there only a short while, however, before it became obvious to her that this was the area for her. She plans to incorporate this experience into her dissertation. Now, when Cooper gets her degree in 1990, she wants to continue her ICU research and to teach.

When Cooper is not studying or working, she enjoys following college basketball. However, you won't find this fan wearing blue and white. Her favorite teams are the North Carolina Tarheels and the Cardinals of the University of Louisville, where she got her associate and B.S. nursing degrees.



Sally Hicks: Physics

"I can't remember the last time I was bored," says Sally Hicks. "I think you have more fun here she's in her sixth year of graduate study in nuclear physics and will receive her doctorate in May, 1988 than in the real world. I get to do what I want to do."

This 28-year-old native of Moscow, Ohio is studying calcium 48, such a rare isotope that her sample—the size of a small piece of chalk—is worth one to two million dollars.

"I am very scared every time I handle it," says Hicks.

Her goal is to learn about the basic nuclear structure of the isotope. Because the isotope's nucleus is too small to be seen with any microscope, Hicks uses a procedure called neutron scattering. In this process, the sample is placed in the neutrons produced with Van de Graff accelerator beams. The accelerator, in a nitrogen atmosphere, is housed in a 24'-high, 17-ton tank in the UK Chemistry-Physics Building. The sample is bombarded with neutrons at energies ranging from two to eight million electron volts. The angles at which the neu-

trons scatter reveal various properties of the nucleus, including its size and shape, and reveal the neutron interactions with protons and other neutrons.

"These experiments are quite elaborate," says Hicks. "I would spend as much as a week just setting up—getting the detectors, electronics and computer ready."

Although she admits to being committed to her studies, confessing to only five days off this past summer, Hicks says she's just like any other graduate student. Furthermore, she enjoys her work, an attitude her advisor confirms.

"Sally carries with her a real spirit of joy about her work," says Dr. Marcus McEllistrem, a UK professor of physics. "She makes jokes and her attitude toward people is always encouraging and optimistic."

After getting her doctorate, Hicks and her husband, Steve, who got his doctorate in nuclear physics in December (1987), plan to apply for postdoctoral positions. Hicks is concerned that this transition—not exams or defending her thesis—will be the most difficult challenge of her career thus far.

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Kathy Franklin: Plant Pathology

"Filling in the pieces of a larger picture" is how graduate student Kathy Franklin describes her research. Working toward her doctorate in plant pathology, Franklin, 31, is studying the tobacco vein mottling virus (TVMV). This virus is a member of a family of viruses that attack hundreds of plant species, making them susceptible to other pathogens, interfering with their growth, or killing them.

"Our question centers on how TVMV replicates," says Franklin. "In most plant systems, we don't know how the plant viruses replicate."

Replication is the process by which the virus makes more of itself. An RNA virus, TVMV consists of a strand of RNA. Like all viruses, TVMV is a parasite; it lacks certain necessary structures to survive independently and must invade and subvert its host to its own use.

When a plant becomes infected with TVMV, the virus' RNA invades the plant's cells. Through a complicated process, the virus takes over

plant cells and continues to grow, damaging the plant through physiological disruption.

For Franklin, working in a relatively unstudied area has had its advantages and disadvantages.

"It allows you to formulate your own approaches to the project, because not a lot is known about replication of plant viruses; but, you can do a lot of floundering," says Franklin. "The literature on different groups of plant viruses is so new. Each month more comes out so I have changed my strategies and adapted my thinking because of new information."

For Franklin, the most enjoyable part is this learning process, especially when the idea she's thought through works. But this process can also be a source of frustration.

"It can be discouraging to do something and see it's not going to work and it's back to the drawing board," says Franklin. "It makes you realize that your thinking has limitations because you haven't solved the problem."

Even though she has a B.S. degree in agricultural science (from the University of Illinois at Urbana), Franklin has not always had a career interest in plant pathology. Several years after graduating, she took a job washing lab dishes in a plant pathology lab at the college. Three months later, Franklin was given a job as an assistant to a virologist and, as she says, "got turned on to it."

"Plant pathology was one of my favorite courses in college," says Franklin. "However, it hadn't occurred to me as a profession for myself."

At the suggestion of her boss, Franklin then got her master's in biology from the University of Alabama in Huntsville. When she receives her doctorate in the fall of 1988, Franklin wants to continue her research in a postdoctoral position. Keeping in sight a practical use for

her work, Franklin says, "The ultimate goal is to use this knowledge to decrease the incidence or severity of this disease or to strengthen the plant to resist it. These are the kinds of things I will be working on in the future."



Brenda Logan Cappuccio: Spanish

Ever since she took her first course in high school, Spanish graduate student Brenda Logan Cappuccio has felt a strong affinity for her topic of study.

"It had castles and knights; it was an escape from life in rural Indiana," says Cappuccio. "Also, it made sense to me in a way that nothing else did."

With this love of the Spanish language and culture, Cappuccio, 39, has spent the past five and half years pursuing her doctorate. Combining her interests in feminist psychology and poetry, this Kokomo, Indiana native is studying the poetry of Gloria Fuertes, well known in Spain as a

contemporary poet and writer of children's literature.

"I wanted to find out why she is so famous," says Cappuccio. "Poets in any country are not that popular. Plus, she's a female in a traditionally macho society."

To answer this question, Cappuccio is extensively studying the life and writings of Fuertes. Funded by a fellowship, Cappuccio spent a semester in Madrid, where Fuertes lives. While there, Cappuccio talked with the poet and to literary critics who had written about the poet; she also attended Fuertes' poetry readings and listened to her read her work on children's shows.

"My trip made a monumental difference in my dissertation," says Cappuccio. "I'm much more in tune with who she is."

She also brought some of Spain home with her when she met and married Raul Cappuccio.

The second part of Cappuccio's research involves analyzing Fuertes' poetry. Working with a thesaurus and several dictionaries, she first studied Fuertes' work as a whole, looking for recurring themes, images and stylistic techniques. Then Cappuccio analyzed certain poems, word by word, considering the placement of each word and punctuation mark.

"Because poetry is such a concentrated genre, every sound, syllable, and punctuation mark is significant," says Cappuccio. "Taking the poems apart and then reassembling them helps me to better understand the poet's vision, something I need to do as a literary critic."

Through this analysis, Cappuccio found a unique voice in Spanish literature. Describing it as "very prosaic, direct, and deceptively simple with fabulous rhythm," Cappuccio says the poems' themes address universal concerns such as the need for connection, love and death, and war and peace.

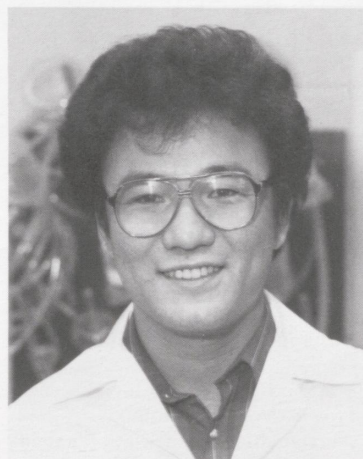
Working toward completing her

doctorate and studying Fuertes' life have allowed her to define her own life, says Cappuccio. She returned to school six years after getting her master's degree when she felt the need to have her own career.

"My son, Stewart, was starting kindergarten and starting his own life; my former husband had his work," says Cappuccio. "I realized it wasn't going to be enough: I thought 'What is mine?'"

Obtaining a doctorate in Spanish so that she could teach on a college level was the logical choice. With her B.S. in secondary education from Ball State University in Muncie, Indiana and a master's in elementary education from Indiana University at Fort Wayne, Cappuccio has been teaching and tutoring Spanish since 1973. Not only does she enjoy teaching but it's a way to continue a tradition.

"I had exceptional Spanish teachers all along the way," says Cappuccio. "It's a way to say 'thank-you.'"



Paul Kou: Physiology & Biophysics

Physiology and Biophysics graduate student Yu-Ru Kou credits his first

college advisor for two important things: an introduction to physiology and his American name.

While an undergraduate at Tunghai University in Taichung, Taiwan, Kou chose Dr. Paul S. Alexander, an American, to be his advisor because Kou wanted to improve his English language skills. Under Alexander's tutelage, Kou, 31, became interested in his advisor's field, physiology. After getting his biology degree and working at the National Defense Medical Center in Taipei, Taiwan, Kou came to UK to pursue a doctorate. He says that everyone kept asking him what his American name was.

"So I said 'Paul,'" says Kou, after his former advisor. "I thought it was a good name."

Pursuing his interest in physiology, Kou is now in his fourth year of graduate work, focusing on two separate but interrelated projects. In one of these projects, Kou is studying the bronchoconstrictive effect in the lungs that is evoked by cigarette smoke inhalation. Working on this project with his advisor, Dr. Lu-Yuan Lee, Kou will incorporate the work into his dissertation.

"Everyone knows smoke causes bronchoconstriction and airway irritation," says Kou. "However, there are a lot of sensory and motor mechanisms in the body that are stimulated by smoke that could play a role in this process."

In particular, Kou and Lee are studying the role that airway and lung sensory receptors play in initiating this protective response. Nerve signals generated from these receptors are carried by the vagus nerve, which is the major pathway conducting nerve signals to the brain.

The second project, which Kou is doing for his own interest, involves Lee and Dr. Donald Frazier, chair-

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man of the physiology and biophysics department. They are studying the nerve impulses as they travel through the vagus nerve. This pathway consists of thousands of individual nerve fibers that are connected to receptors in the airways and lungs. Some of these receptors are normally inactive; once stimulated by the smoke inhalation, the receptors fire impulses at a rate of 10 to 20 per second to the brain. Using a recording electrode and other electronic instruments for studying the neurophysiological signals, the researchers can listen, watch and analyze these impulses.

"We're trying to learn exactly how these receptors behave," says Kou.

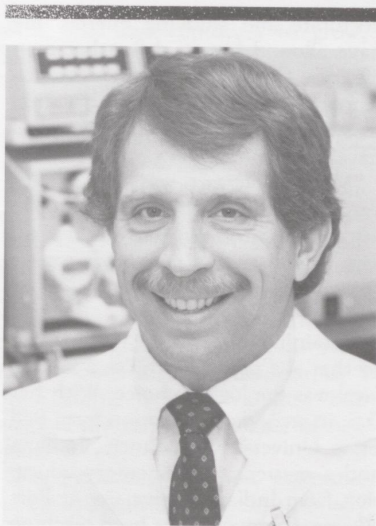
Working on a project simply because he is interested in the subject is not unusual for Kou. According to Frazier, Kou is an active member of the department, both in the laboratory and in class.

"Paul has a passion for reading and has an excellent recall of what he reads," says Frazier. "Sometimes he reads beyond the professor so his questions push the professor. It keeps the environment stimulating."

Lexington is quite different from Kou's native city of Taipei. When he's not working or studying, Kou enjoys watching cable television, something his country does not offer. He also thinks that snow, which he saw for the first time in Lexington, is beautiful. This winter, one of Kou's goals is to learn to snow ski.

Kou speaks highly of the U.S., saying that the environment is ideal for living and working. However, when he obtains his doctorate in 1989 and then works for a few years in a post-doctoral position, Kou plans to return to Taiwan.

"Physiology programs are just developing in my country and they need people like me with first-hand knowledge," says Kou.



Mike Townsend: Pharmacy

A major problem for a recipient of a kidney transplant is the body's tendency to reject the new, foreign organ. Working on the solution is a team of researchers, including pharmaceutical technology graduate student Mike Townsend.

In his fourth year of graduate school, Townsend, 40, is studying a monoclonal antibody, a protein, which is currently under clinical investigation directed by Dr. John Thompson, chairman of the UK Department of Medicine. An injectable pharmaceutical, this antibody degrades easily in its highly purified form and does not remain viable for very long. To address this problem, Townsend is investigating the effect of freeze-drying the antibody.

"Freeze-drying is a way of stabiliz-

ing the antibody," says Townsend. "It's not a new process—many antibiotics undergo it—but working with proteins is."

The first step for this native of Fairborn, Ohio was to develop a method that would ensure the monoclonal was in a highly purified form. Working on this process for two years, Townsend used several chemical and physical techniques, including a synthetic ultrafiltration membrane. When the solution is quickly passed over the membrane, molecules of a certain size pass through while others, including the monoclonal, are rejected and stay in the solution.

After obtaining the monoclonal in a highly purified form, Townsend began the freeze-drying experimentation. Because the antibody is susceptible to degradation during freeze-drying and while in storage, Townsend had to formulate a proper solution for the antibody. Creating an environment that mimics the bloodstream, Townsend added distilled water, a buffer (sodium phosphate), sodium chloride, sucrose, and maltose to the solution. This process ensures that the antibody will not precipitate out of solution when it is reconstituted, a common dilemma when freeze-drying.

Presently, Townsend is near the end of his project and is finishing his dissertation. He has successfully manufactured and freeze-dried the monoclonal antibody, and the product is being used in the UK clinical trials. Townsend says that this application gives him a sense of satisfaction.

"It feels good to make a contribution, to see a use for your research," says Townsend.

Considered a non-traditional student, Townsend returned to school 10 years after getting his master's in microbiology at the University of

THE SUPER POWER OF SUPERCONDUCTIVITY

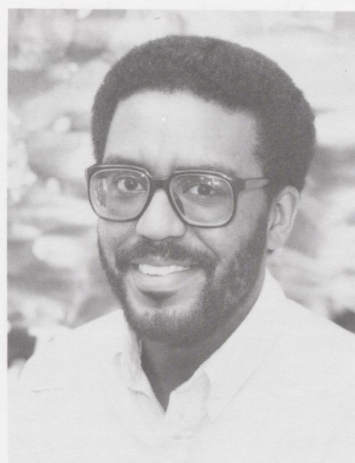
Illinois at Urbana. However, Townsend says he has no regrets. Those years spent at The Upjohn Company in Kalamazoo, Michigan are what sparked his interest in the manufacturing of pharmaceuticals, of which freeze-drying is one area. Desiring to move up in management in a pharmaceutical company, Townsend knew he needed a doctorate and so he chose pharmaceutical technology.

Being a student again has had its advantages and disadvantages. Townsend says that financially it has been very difficult, but that the work has been stimulating.

"I enjoy the freedom of being able to formulate my ideas, work them through, come up with conclusions and move on a logical pathway," says Townsend.

After getting his doctorate in 1988, Townsend and his wife, Marianne, are moving to Syracuse, New York where he has a position with Bristol Laboratories in the manufacturing of injectable pharmaceuticals, a job that will suit him fine.

"The manufacturing of injectable products interests me because it involves a lot of technology," says Townsend. "They present the greatest challenge to the pharmaceutical scientist."



Maury Granger: Economics

Calling himself a "people-person," Maury Granger is pursuing a doctorate in economics to solve people problems. In his third year of graduate school, Granger, 28, is especially interested in the economics of cities, particularly business location theory—models which describe and predict business location.

"Since the end of the second world war, there has been a trend toward population decentralization," says Granger. "It creates a problem for cities in that as people move away from the central business district toward the urban fringe or suburbs—businesses also migrate—employment opportunities fall, the stock of surplus and abandoned real estate rises, tax revenues fall and, in some cases, a cycle of decline sets in."

Finishing his economics coursework, this Louisville native is considering dissertation topics. One idea he is thinking about is urban revitalization—with emphasis on business location. According to Granger, urban

revitalization is a complex problem that is affected by many forces. He feels that an emphasis on adequate levels of business and employment in an area is critically important and reflects a healthy community.

If a community isn't healthy, this condition creates other problems, such as juvenile delinquency, crime, lack of adequate health care and education, according to Granger. "For example, it's widely accepted that high unemployment is closely correlated with rising social problems."

An interest in the community is something that Granger has had all his life. He points to a strong family orientation and to active involvement in the Newburg (a city near Louisville) community while in high school and as an undergraduate at the University of Louisville. For example, he served as president of the U of L NAACP chapter, youth commissioner and board member for the Newburg Area Council, and as a member of the board of Louisville's Community Action Agency.

Strong family support is also a reason Granger feels he has gone as far as he has.

"All through my life, my mother told me to excel, to do more, to push myself," says Granger. "I never thought I'd get a bachelor's degree and be through with school."

His family is also the reason Granger keeps on when life gets hard. He says his daughter Ameerah, 10, and a niece, Rasheedah, 6, are his two main motivations.

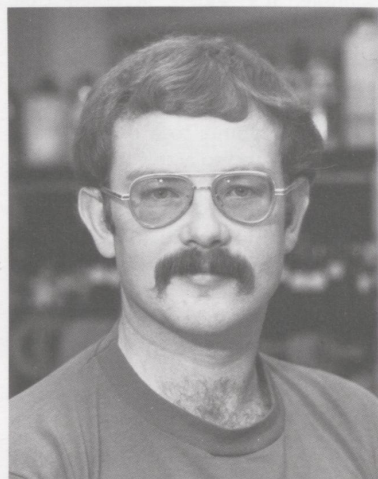
"Graduate school is difficult," says Granger. "When I go home to see my

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'girls,' it's hard to come back and focus on my lessons."

Despite studying six to seven hours a day and being away from his family, Granger feels graduate school has its rewards.

"The best thing," says Granger, "is to see myself developing a clearer picture of what makes the world turn."



Carroll Teater: Biochemistry

There was a time when Carroll Teater did not want to ever step back into a classroom. A bad high school experience left him looking for a job, not a college degree. However, after working for two years as an electrician, he got bored. This Lancaster, Kentucky native then decided to major in biochemistry at Eastern Kentucky University.

"I never quit reading after high school," says Teater. "I had read a lot of Isaac Asimov and knew he had a

doctorate in biochemistry. I was impressed because he seemed to know so much about everything."

Teater's choice of study proved to be the right one. After getting his chemistry degree (biochemistry was not offered as an undergraduate major), he came to UK and earned a Lucille P. Markey predoctoral fellowship. At 16 institutions around the nation, this prestigious program provides a \$10,000 living stipend and pays for tuition, books, and travel expenses while the recipients are in graduate school.

In his fourth year of graduate work, Teater, 27, is researching the binding of three inhibitors, known as transition state analogs, to a zinc enzyme. Inhibitors, which have important medicinal purposes, function by binding to an enzyme at the site that a substrate normally would and thus prevent the enzyme from working.

Although he enjoys attending the university, he didn't always think so favorably of UK. "I had a bad image of UK and wasn't considering coming here," says Teater. "It wasn't until I checked out the department that UK became my preferred choice."

According to Thomas Vanaman, chairman of the biochemistry department, UK is fortunate to have Teater.

"He could have gone to Harvard," says Vanaman. "It's nice to see students as good as Carroll stay in Kentucky. He's the kind of student the Markey fellowship program is going to be proud of."

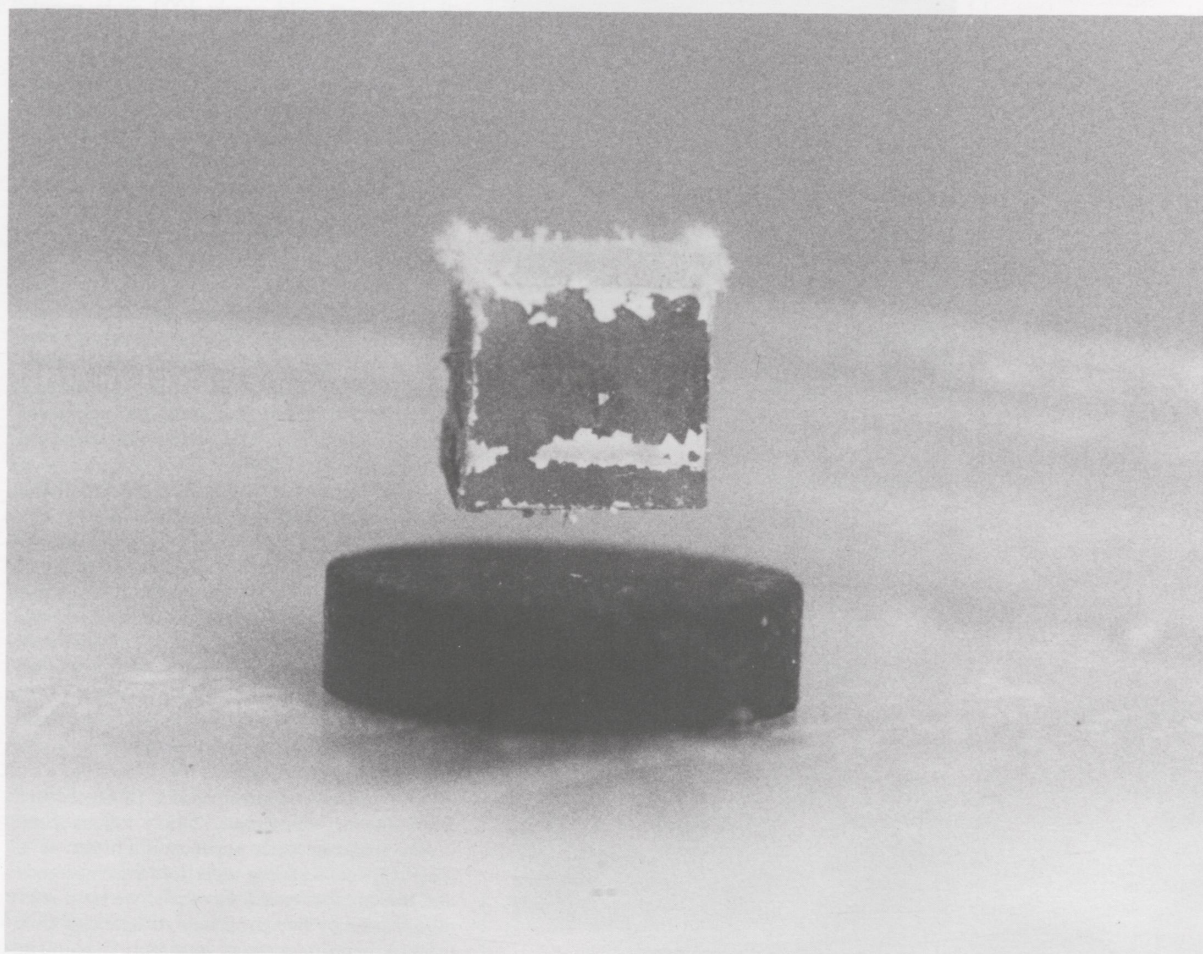
Teater and his wife, Cathy, have a young son—Johnathan.

After getting his doctorate in the fall of 1988, Teater will be moving on to spend several years in a postdoctoral position. However, his career goal is to return to the classroom.

"I want to teach freshmen the excitement of discovering science," says Teater. "I want to teach people how to think for themselves." ■

THE SUPER POWER OF SUPERCONDUCTIVITY

by Jeff Worley

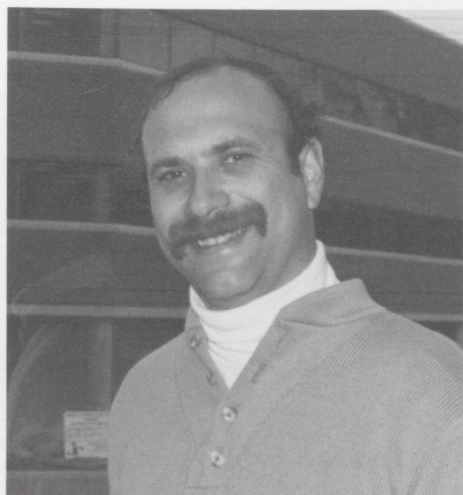


The group was scheduled to begin their performance at 7:30 p.m., but lines began forming around the doors over an hour early. When the doors opened, the crowd ran for the seats, people pushing and shoving toward the front. A bearded man with a coveted first-row seat stood up to look around the room. A small woman wearing a flower-print blouse elbowed her way into his seat. A rhythmical clapping began in the

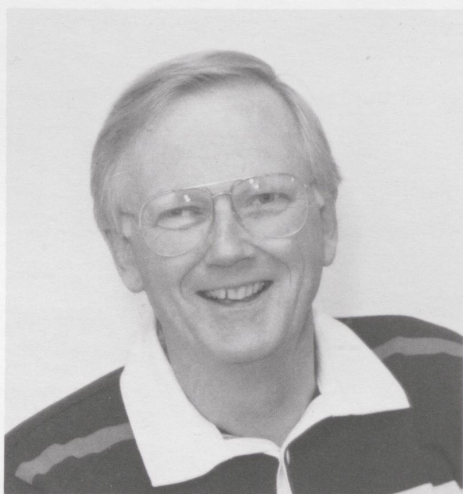
A unique property of a superconductor is demonstrated. Its temperature stabilized by liquid nitrogen, the small (1/2"-diameter) disk of superconductive material 'levitates' a 1/4" magnet. This property, called the Meissner effect, will facilitate levitation systems, such as Japan's floating train.

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“Nuclear reactors could be put in the middle of non-inhabited areas, in Arizona, for example, and the power generated could be used in Chicago.”



Joseph Brill, Physics and Astronomy



Charles Hamrin, Chemical Engineering

back, catching like wildfire, until the whole room rocked with noise.

Within three minutes the crowd had filled all 1200 seats, and nearly 1000 more people clogged the aisles and pressed against the walls.

The applause was not for Bruce Springsteen, the pushing and shoving not for a close-up view of Madonna. The crowd consisted of physicists from three continents, eager to discuss recent breakthroughs in superconductor research. Some scientists have called the March 18, 1987 conference at the New York Hilton the “Woodstock” of physics.

Dr. Joseph Brill, University of Kentucky associate professor of physics and astronomy, was at the meeting. “There’s probably never been anything like it in the history of physics,” Brill says. “Superconductivity has been a ‘Holy Grail’ for a long time, and this session of the American Physical Society promised all kinds of new revelations.”

“When I read the front-page *New York Times* article reporting the meeting,” says Dr. Charles Hamrin, UK professor of Chemical Engineering, “I wondered what in the world could be so exciting. In the past thirteen years there had been no increase in the ‘critical temperature,’ the temperature at which material goes superconductive.” Hamrin mentions that almost all of the groups which had been working on superconductivity—Brookhaven National Lab and Oak Ridge National Lab, for example—had been disbanded.

“The enthusiasm generated by this technical meeting was contagious. Many of us here began working with superconductivity at a feverish pace, scraping together what materials and furnaces we could. Recently, we have submitted four or five proposals to agencies that fund superconductivity research,” Hamrin says.

Superconductivity, the passage of electric currents without resistance, is a simple property. It appears in various substances as they are cooled toward absolute zero (-460 F), and its onset is fairly sudden as a certain critical temperature (different for each material) is

passed. Since in ordinary materials that conduct electricity, such as copper wire, the flow of electricity is resisted, energy is wasted. Superconductors operate with no such resistance.

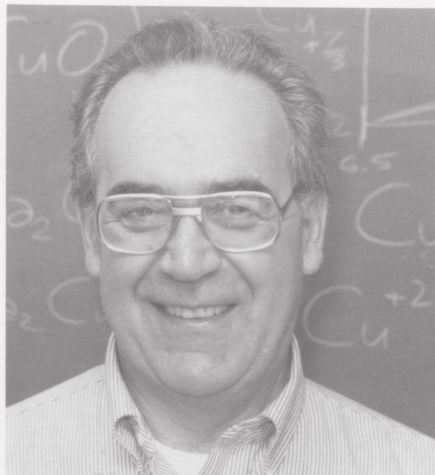
As temperatures at which superconductivity becomes possible climb, many commercial applications should be possible. Medical scanners, which now use liquid helium, could be made much more efficient and less expensive. Nuclear reactors, built far from inhabited areas, could use superconducting transmission lines, assuring no loss of power. The magnetic properties of superconductors could facilitate levitation systems, such as Japan's floating train, or automobiles that glide along a few inches off the ground.

Researchers Hamrin, Brill, and Robert De Angelis, professor of metallurgical engineering, have made materials at the University of Kentucky that are superconductive. "As far as I know, all of us at UK have been working with temperatures at 95 K (-290 F), a temperature at which superconductors are fairly stable," De Angelis explains. "At 95 K, you can go on temperature excursions of a couple hundred degrees and not lose the effect," he adds.

In their work with superconductors, UK researchers are taking a broad approach. One goal is to attempt to improve on the composition of previously tested materials, to find the combination of oxides that will be most conducive to unrestricted electrical flow. A second objective is to discover new mixtures of elements that, when pressed together, function as superconductors. As the researchers gather more information about the properties of superconductors, they will be able to make useful materials. "Our first application here at UK will probably be the making of thin films, the type that are used in electronics," Hamrin says.

De Angelis emphasizes the fact that although the researchers are investigating different aspects of superconductivity, research at the university has been a collaborative effort. Brill has done sponsored low-temperature work, measuring the properties of superconductors. De Angelis has X-ray diffraction

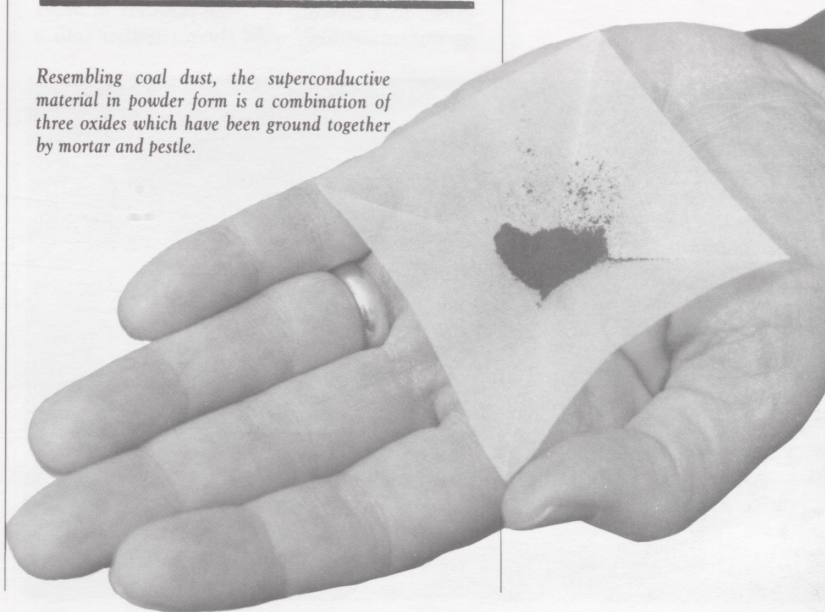
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Robert De Angelis,
Metallurgical Engineering

Superconductors in computer boards for supercomputers will make transmission, literally, quicker than lightning.

Resembling coal dust, the superconductive material in powder form is a combination of three oxides which have been ground together by mortar and pestle.



“It’s so exciting because of the possibility of any one of a thousand people at any moment making a tremendous breakthrough.”

equipment that enables him to determine the crystal structure of each sample. Dr. Kenji Okazaki, professor of metallurgical engineering, has experimented with superconductive metals. And Dr. Lance DeLong, associate professor of physics and astronomy (who also attended ‘Woodstock’), has done extensive work in the field, most recently with Dr. Peter Eklund, also an associate professor of physics and astronomy. The two are currently working on developing a new method of thin-film synthesis using ion-beam techniques.

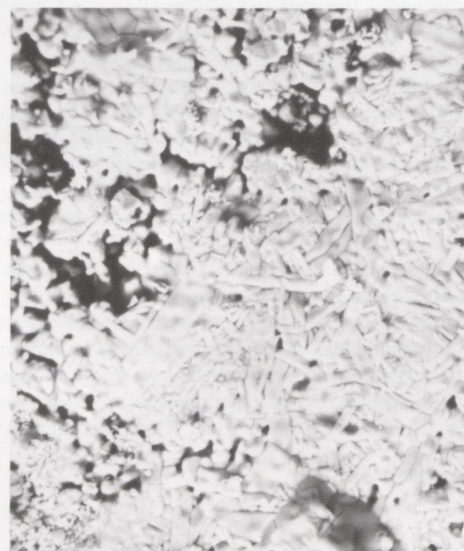
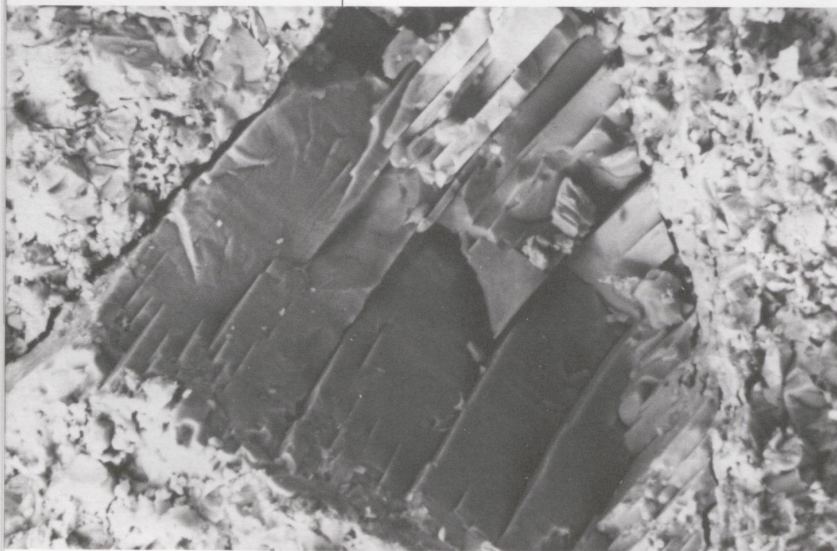
“Charles Hamrin is the main one responsible for pulling us all together,” says De Angelis. “He’s the sparkplug.” De Angelis adds that an attractive aspect of recent research is the camaraderie that has developed among researchers. “The group cuts across departmental and political boundaries. We write proposals and articles together and that’s the first time this has happened.”

Such collaboration has recently resulted in the securing of a National Science Foundation grant which runs through April of 1989. The funded project, under the direction of Okazaki, will focus on the processing of superconducting composite materials by electro-discharge compaction. This procedure involves applying a very high voltage, a high-current pulse, to a mixture of oxide powders in order to instantaneously weld them together into a

solid piece of material that may have superconductive properties, Okazaki explains. De Angelis and Hamrin will be assisting Okazaki in this project. “I wasn’t actually surprised that we got the grant—it’s kind of a continuation, really, of a previous NSF grant,” Okazaki says. “What makes it unique is that I’ll be working with Charlie [Hamrin] and Bob [De Angelis] for the first time. We’re all pretty excited about it.”

The recent flurry of activity at UK is indicative of the aggressive nature of superconductor research worldwide. The great amount of work done in such a relatively short time has, itself, caused a revolution of sorts. Journals which ordinarily take a year or more to get an article into print have adopted special procedures to publish articles on superconductivity much more quickly. “A recent paper on superconductivity that Robert De Angelis, Joseph Brill and I submitted,” says Hamrin, “was

First satellite photographs of the Venusian surface? No, these photographs, taken using an electron microscope and enlarged up to 2000 times, show the surface area of a pressed sample of superconductive material. Often as little as ten percent of a pressed sample is actually superconductive material, particles that are in contact in just the right way.



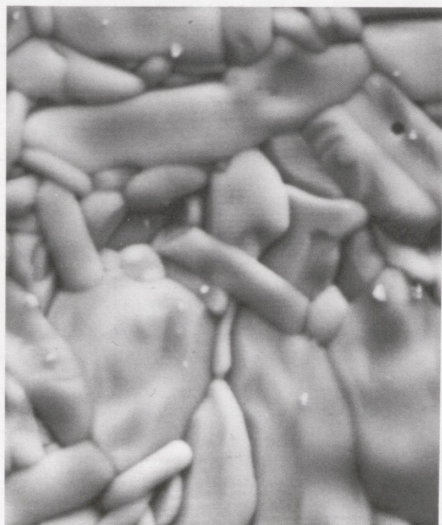
received the Friday before Labor Day and accepted the following Tuesday!"

Many of the papers reaching print so quickly deal with the composition of various superconductors, now made primarily of ceramic materials instead of metals or alloys. De Angelis characterizes the making of a superconductor as "a relatively easy procedure." He is currently experimenting with a combination of barium oxide, copper oxide, and neodymium oxide, which are ground together by mortar and pestle. The materials are fired together in a kiln at 950 C, at which point they begin reacting with each other.

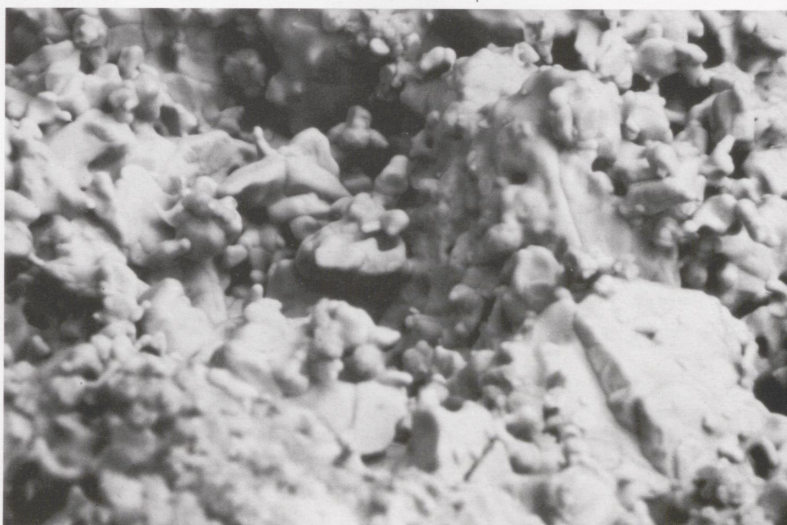
After twenty-four hours in the kiln, the materials are ground up again to increase contact, then are re-fired so that the bonding among the elements is tighter. The material is then ground a third time and pressed into a bar-or pellet-shape approximately 1/2 inch in diameter. "Once we press the material," De Angelis explains, "we re-fire it under an oxygen atmosphere for five to fifteen hours, then cool it slowly to a low temperature. During this last firing, the shape centers together."

"These pressed samples are really pretty lousy chunks," says Brill. "Under an electron microscope they look like swiss cheese—there's a lot of surface area. Thirty to forty percent of the material is holes," he explains.

Often as little as ten percent of a pressed



Peter Eklund, Physics and Astronomy





Lance DeLong, Physics and Astronomy

sample is actually superconductive material, small particles that are in contact in just the right way. This tiny part of superconductive material, called a percolating thread, is easily broken. When crystallites move, expand, or shrink (which they do when heated or cooled), the thread often breaks.

If a sample is heated to room-temperature range, it becomes extremely sensitive and unstable, a problem that researchers have attempted to solve, in part, by altering the ingredients. This approach has given rise to what has been called "Julia Child" research: mixing all different kinds and combinations of materials in hopes of hitting upon the right recipe. "This Edisonian approach," says Hamrin, "has a lot of hopes riding high. IBM just presented a paper discussing 300 variations they tried—they must have just stopped short of throwing in everything in the periodic table—using four or five materials."

Hamrin says that scientists experimenting with room-temperature superconductors have found "strange things." "Experiments with superconductivity at room temperature have not generally been reproducible. There's a transient effect and, so far, no single theory fully accounts for this effect." UK researchers are not currently involved in doing room-tem-

perature experiments, though, Hamrin suspects, "that's probably always in the back of our minds."

A major problem UK researchers have had in their experiments involves the contacts, copper leads, that must be fastened to the material so that current and voltage can be measured. "I worked night and day," Brill states, "and three graduate students worked night and day, trying to get the contacts to stay on. I don't mean *physically* on, but the contacts would form an insulating barrier, a film that formed so no current could get through."

Brill believes that the problem might be a geographic one: "I talked to people at Berkeley who said, 'We don't have that happen'; then I talked with people at Oak Ridge or in Ohio who said, 'Yes, we have that happen all the time too.' I think it's related to humidity—these samples are extremely air-sensitive and water-sensitive," Brill says.

The problem in Kentucky is, not surprisingly, most acute in the summer. Brill recalls taking part in a superconductivity lecture and demonstration given for the media last June in Anderson Hall. After the demonstration, Brill left with the sample he had used, but did not wrap the chunk in anything to protect it from the heat. "I just carried it across campus on a hot, muggy day," Brill explains. "Water vapor began to condense on the cold material, and it turned from coal black to chalky white. By the time I got back to the Physics building, it looked like I was carrying around a piece of bird dung."

UK researchers are able to devote only part of their time to superconductor research; the fact that there are so many scientists working full-time in this area is "humbling," according to Brill. "It's extremely hard to compete with the industrial labs, such as Bell Labs and IBM," he says. "They have better facilities and better equipment." De Angelis cites one example of this commitment by industry: "I read an article in April that said people at Bell Labs hadn't been home overnight since Christmas—months went by with them working around the clock."

Corporations are interested in superconductors because of their economic potential. Superconductors are already important for making powerful electromagnets which are

cooled with liquid helium to reduce the amount of current required to produce a powerful magnetic field. "Probably the first widespread application of the new materials will be in the magnetic resonance imaging devices that hospitals use," says Hamrin. These machines contain powerful magnets and must be placed close to a patient's brain. The devices now require liquid helium (for conventional, pre-1987, superconductors), which is relatively difficult to work with; the new superconductors will use liquid nitrogen, which will make the machines much simpler to operate.

Another application in the near future, according to De Angelis and Brill, will be in the area of electronics. Superconductors in computer boards for supercomputers will make transmission, literally, quicker than lightning.

Brill believes that prototype lines for power transmission will be designed within a few years. In discussing a future where superconducting transmission lines supply power to cities hundreds of miles away, skeptics have pointed out the near impossibility of making wires from such brittle material. But Brill is optimistic: "Free-standing wires may not be necessary at all. Maybe a copper wire could be impregnated with superconductive material. We know that brittle material can become extremely flexible if it is made thin enough—in fiber optics, for example. Perhaps such superconducting wires can be made that would wrap around your finger like a hair."

Hamrin says that many of the applications of superconductors will eventually be bounded only by economic concerns. "Nuclear reactors could be put in the middle of non-inhabited areas, in Arizona, for example, and the power generated could be used in Chicago. Since liquid nitrogen would have to surround the wires, though, this would be tremendously expensive—another order of magnitude above the Alaska Pipeline."

Brill agrees that economics, more than anything else, will determine the extent of superconductor use. "Levitating cars? Levitating trains? The Japanese already have prototypes of trains 100 meters long that operate by use of liquid helium superconductors. They work, but the Japanese haven't decided whether or not it's economically feasible to operate a train



Kenji Okazaki, Metallurgical Engineering

“Levitating cars? Levitating trains? The Japanese already have prototypes of trains 100 meters long that operate by use of liquid helium superconductors.”

system this way,” Brill states.

For now, the search that might put scientists in sight of this Holy Grail is excitement enough. "It's an opportunity to be on the edge of science as it's developing," says De Angelis. "It's so exciting," Hamrin says, "because of the possibilities of any one of a thousand people at any moment making a tremendous breakthrough. This is the greatest democratization of science that's ever been known." ■



INSPIRATION POINT

UK Cancer Center
Provides Environment for a Meeting of the Minds on Cancer

by Maria Braden

Envisioned by scientists as an "inspiration area," the three-story atrium in the University of Kentucky Combs Cancer Research Facility is flooded with sunlight. When researchers move into the building early this year, they will find comfortable chairs and couches there, helping to create an environment intended to encourage discussion and productive exchanges with colleagues from points all over campus.

Resulting from a collaboration among scientists, architects and engineers, the atrium is one of the more unusual features of the building.

"It's a building designed for scientists as human beings," says Dr. Judith Lesnaw, an associate professor in

the School of Biological Sciences who is one of four program leaders and who serves on the cancer center's internal advisory committee.

The building was, in fact, designed to catalyze cancer research at UK, not only by providing space for new laboratories and state-of-the-art equipment, but also by bringing together scientists from different disciplines.

Collaboration:

Dr. Mary Sue Coleman, a professor in the Department of Biochemistry and associate director for research in the cancer center, says she hopes the new facilities will provide incentives

for faculty members to cut across disciplinary lines.

"We want to carry out studies, to try to get people from different disciplines to focus on cancer," explains Coleman. "For example, if you can get people who are trained in biochemistry together with people who are trained in virology, and get those people together with experts in bone marrow transplantation who are clinicians, then maybe some new things will come out of it," she says. "You don't have to have a new building to do that, but it helps."

"Research also comes out of patient care," states Dr. Gilbert Friedell, professor of pathology and director of the cancer center.

"The idea is that there will be cross-stimulation . . . the trick is to get collaboration of investigators cutting across department lines. This permits you to focus on many problems generated by the study of cancer patients," he said.

"That's what we're about: providing the best care for cancer patients and their families, studying mechanisms of disease and applying new therapeutic approaches. Our research also includes looking at means to improve the way in which psycho-social support is provided to cancer patients and their families," Friedell says.

Coleman agrees: "If the cancer center is going to have an impact on society, then we need to think about patient-driven care."

While it's not unusual for researchers to begin asking questions based on the study of actual diseases, cancer centers differ from research institutes in that centers encompass research, treatment and rehabilitation, according to Friedell and Coleman.

The Facilities:

UK's Lucille Parker Markey Cancer Center is still in its infancy. Designated a Clinical Cancer Center by the National Cancer Institute last year, UK is one of 41 such centers in the nation.

Financial support for cancer center operations comes mainly from the state and from an NCI grant. Research activities are funded largely by grants to individual investigators from NCI, other institutes in the National Institutes of Health, the American Cancer Society, and other organizations and individuals.

More than 120 scientists from 26 university departments are involved in basic or clinical research that relates to the understanding of cancer, with research taking place in labs all over the UK campus. However, cancer research is concentrated in "core" laboratories in the new two-building cancer complex adjacent to the



Chandler Medical Center.

The Ben F. Roach Cancer Patients Care Facility, named after the Lexington physician who helped plan and raise money for the complex, was the first part of the complex built. The Roach facility is a four-story building with 28 private rooms for cancer patients, areas for ambulatory cancer care and radiation therapy, and 3,000 square feet of research laboratory space. It also is the home of the McDowell Cancer Network and the Ephriam McDowell Cancer Research Foundation, the organization that raised the funds for the complex.

The Dorothy Enslow Combs Research Facility, dedicated last fall, contains 20 offices and 21,000 square feet of lab space. A specialized animal research unit is included. There are six core laboratories in the Combs facility with state-of-the-art equipment available to all UK cancer researchers.

The core laboratories are in sharp contrast to existing facilities, where "core laboratories were not specifically designed," says Coleman. Other research facilities on campus have not in the past had tissue culture labs, for example. Researchers "often just gerrymandered it," she says.

Much has happened in a relatively short time. Friedell says that when he took over as director in 1983, there was the promise of one new structure, possibly two. The university had made a commitment to develop a cancer center integrating the activities throughout the university, but there was no organizational structure and little physical structure, Friedell adds.

For a couple of years, the headquar-

Large open areas and tall windows combine to give the structure a sense of spaciousness.

ters was above Checkers Delicatessen on South Limestone Street. "No doubt about it, lunch was more convenient," jokes Friedell, "but having this building and Combs means we now have a very solid geographic center for a cancer program that has many varied elements and participating faculty throughout the university."

The Research Program:

The relationship between patient care and research is fundamental to the operation of the cancer center. Many scientists are carrying out research—and all of it, ultimately, can

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Friedell, director of the cancer center, and associate director Lewis Kelly were part of the UK team which collaborated with architects and engineers to design the new Combs Research Facility.

contribute to better care of the patient.

Sometimes, basic cancer research also contributes to the understanding of other diseases. Dr. Thomas Vanaman, chairman of the UK Department of Biochemistry, says that basic research on cancer viruses has laid the foundation for research on AIDS. "As a result of this research, the causative agent of AIDS was identified in record time. The only current drug for treatment of AIDS symptoms was developed many years ago as an anti-tumor drug," Vanaman adds.

Individual research projects supported by roughly \$6 million in funding are being conducted through the center and grants have increased by about 30 percent over three years, says Dr. Lewis Kelly, associate director for administration.

According to Coleman, in the cancer center research falls into three major areas of emphasis—molecular genetics, tumor immunology, and developmental therapeutics.

Molecular Genetics

Researchers are investigating, at the molecular level, how cell growth and function are controlled in all of their aspects. Work underway in this area includes the research of Dr. Marion Steiner in the Department of Microbiology and Immunology. Under an NCI grant, Steiner is investigating the properties of tumor cells that allow them to metastasize, or spread from one area of the body to another.

Biologist Ricky Hirschhorn has been awarded an NCI grant to examine the regulation of the eukaryotic cell cycle at the biochemical and genetic level. In particular, Dr. Hirschhorn wants to identify and characterize the genes and gene products which control entry into and passage through the cell cycle.

She is investigating the possibility that mutations in these genes or changes in their regulation may be in-

involved in abnormal cell growth such as that seen in malignant tumors.

Tumor Immunology

This area of emphasis is under the leadership of Dr. Alan Kaplan, chairman of the Department of Medical Microbiology and Immunology. The researchers are interested in understanding the normal immune system and in examining the immune response to a malignancy. Scientists want to know, for example, why the immune system doesn't more readily recognize malignant cells as being foreign.

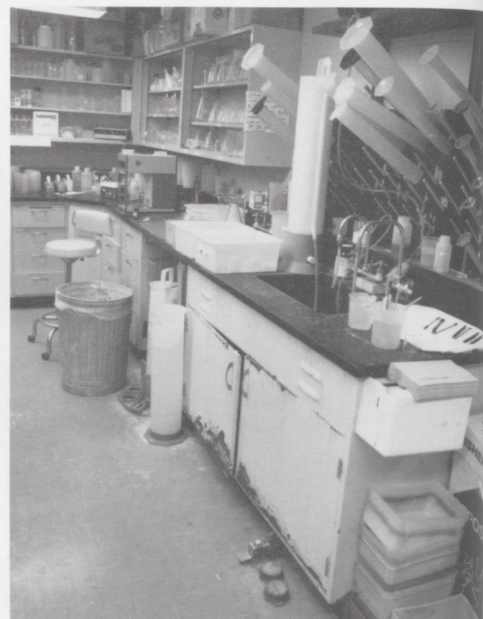
Dr. Jerold G. Woodward in the Department of Microbiology and Immunology has been given an NCI grant to study how certain genes are expressed and regulated in cells of the immune system. He is looking at the gene complex known to be essential in tissue rejection or acceptance which, he says, "seems to be important in the ability of the immune system to reject tumors.

"If we can understand the switching mechanisms of cells, then we can understand why some cancer cells have the ability to switch genes on and off."

Developmental Therapeutics

Headed by Dr. John S. Macdonald, associate director for clinical activities of the Markey Cancer Center and director of the UK Hematology/Oncology Division, this clinically oriented research involves working with new therapeutic agents, combinations of known therapeutic agents, new treatment regimens, and new procedures such as bone marrow transplantation. The aim is to allow a patient to live a longer and healthier life.

Dr. Ernest Marshall, assistant professor of medicine, has had considerable success using the drugs coumarin and cimetidine to inhibit the growth of kidney cancer and activate the body's immune system. The pilot study has been successfully com-



The additional space in the new facility should give some relief to researchers in the many crowded and timeworn labs, such as this one, scattered throughout the Medical Center. The researcher who occupies this lab will be moving into the Combs Facility.

pleted and the drugs are now being tested with patients in the cancer center. The agent being tested is administered in escalating doses to a small number of patients whose cancer has not responded to other available treatments.

Another clinical trial in this area of research involves the use of monoclonal antibodies in cases of colon cancer. As with the other programs, it draws patients from all parts of the country.

Dr. John Neefe, assistant professor of medicine, has been working with agents such as interferon, which enhances the patient's own defense mechanisms against cancer. Interferon, according to Neefe, is effective against some cancers and may be more effective in combination with certain drugs.

Clinical research on bone marrow transplants is also drawing patients from other states and from other countries. The bone marrow transplant program, initiated by Dr. John S. Thompson, chairman of the Department of Medicine, has been effective in using monoclonal antibodies to prevent rejection of transplanted bone marrow tissue. UK is "one of the few places doing this kind of work," says Macdonald.



Mary Sue Coleman



John Macdonald



Judith Lesnaw

Still another of the many projects underway in this area is the work of Dr. Vincent Gallichio, assistant professor in the College of Allied Health Professions. Gallichio is looking into ways to enhance the ability of cells to repopulate the bone marrow following cytotoxic treatments.

Cancer Research:

Macdonald says the public tends to think of cancer as a "monolithic whole," when in fact there are at least 130 different cancers, caused by different things and managed in different ways. This diversity leads to some frustration for scientists doing clinical research. Clinical regimens found to be effective for restricted classes of malignancies seem to have no effect on others.

"There are vast differences, and we don't understand what the differences are," says Coleman. "That is extremely trying to researchers."

"The other thing the public doesn't understand about any kind of basic research is that the questions researchers ask are really very restricted and highly focused because if you don't ask sufficiently specific questions, in general you don't get any answers. That's the nature of science, that things happen in discrete steps," she says. "Every once in a while, someone can have great insight and come up with a new theory—jump light years ahead—but it doesn't happen very often."

"The treatment of cancer is in constant evolution," says Macdonald. "The ideal would be a perfect treatment, with a 100 percent cure and no toxicity or side effects."

"That's not realistic, although huge advances in treatment have been made," he says. "For example, Hodgkin's Disease, a cancer of the lymphatic and other tissues, is now curable 80 percent of the time, and many leukemia patients can be cured."

Lung cancer is a particularly serious problem in Kentucky, with its tobacco-based economy. Although Macdonald says that people could prevent 95 percent of lung cancer cases by choosing not to smoke, he recognizes lung cancer as a serious problem, saying that "to ignore it would be criminal."

Another area of particular concern in Kentucky is cervical cancer. Eastern Kentucky's cervical cancer death rate is in the nation's top 10 percent. The cancer center, along with the state health department and the Federal Center for Disease Control in Atlanta, are engaged in a joint study to determine why some women in Eastern Kentucky countries are dying from cervical cancer when it is curable if treated early.

Friedell sees this as a good example of the way people from different university departments and local, state and federal agencies work together through the cancer center.

Another example of the way in which researchers are forming linkages through the center is seen in Dr. John Neeff's proposal to NCI to provide funding for a biologic response modifier program. Such a program would evaluate the effectiveness of a variety of agents developed both at the university and around the world. A facility would be set up capable of doing early human testing on new interferons, interleukins, growth factors and growth factor inhibitors, Neeff says.

Because a number of investigational skills are required for this proposed program, Neeff has enlisted the support of people from several disciplines to work in such areas as fundamental immunology, drug dosage assessments, protocol development, and data collection. Neeff, an assistant professor of medicine, says he is hopeful that the pooled expertise and skills will help in securing an NCI contract.

Cancer Outreach Programs:

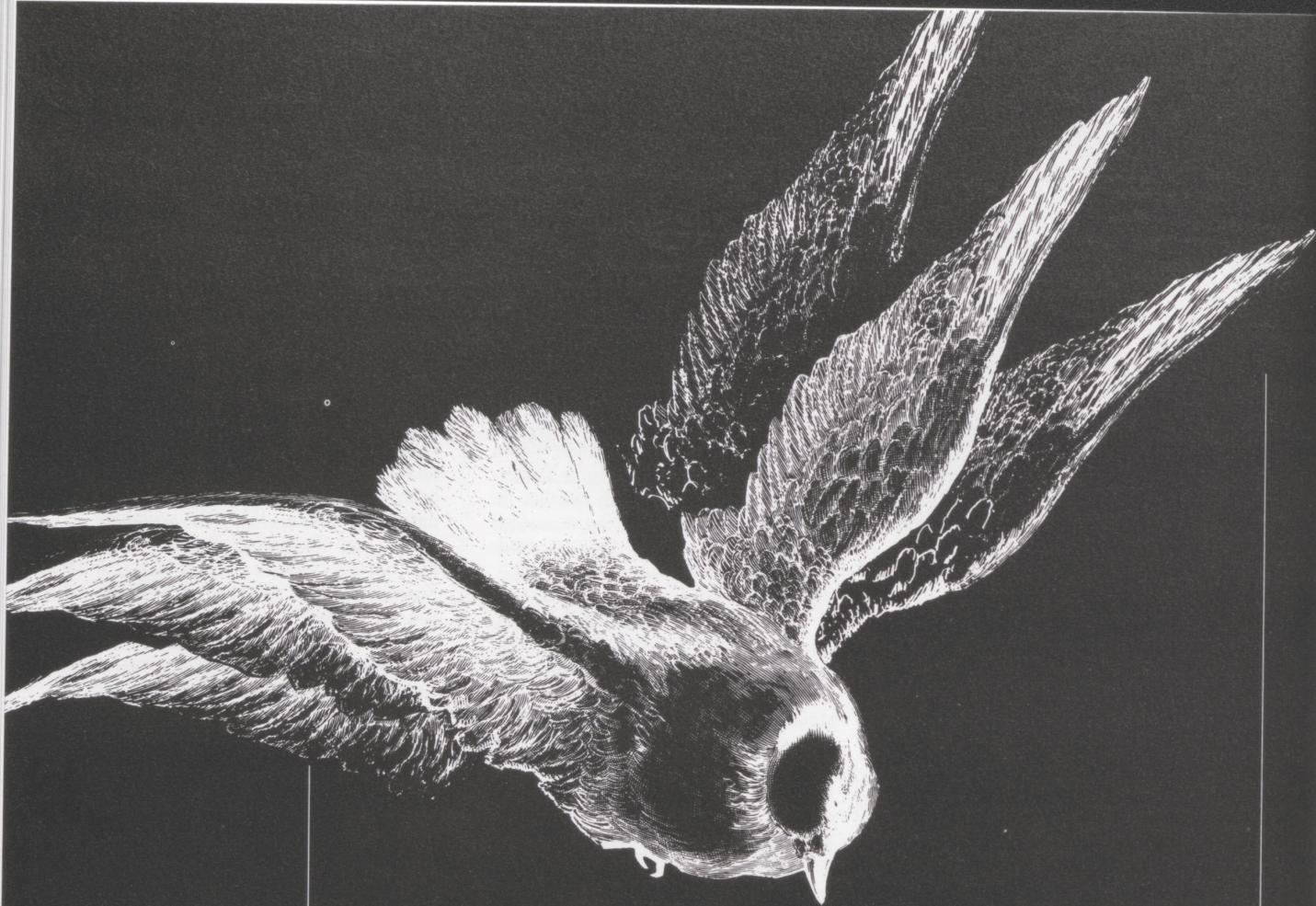
Meanwhile, another of Friedell's objectives for the cancer center has been to establish a statewide cancer patient data base. With the guidance of Dr. Tom Tucker, associate director for cancer control, 20 hospitals in Kentucky have installed microcomputers through which they study their own cancer patients and also feed information into the system. In turn the hospitals receive aggregate data. The cancer center provides software, training and ongoing liaison for participating institutions.

Sharing data on treatment of Kentucky cancer patients "helps us learn whether different kinds of inputs into care, different combinations of therapy, are more or less effective in extending the lives of patients," Tucker says.

Another outreach program, the Cancer Information Service, responded in the last fiscal year to nearly 7,000 telephone calls, 200 walk-in visits and other requests for literature, according to the center's annual report.

Friedell says that patients from all over the country are coming to UK because of the biological response modifier program and other programs related to tumor immunology. And UK has been successful in recruiting researchers for the cancer program. Seven faculty lines have been filled, and two more researchers are being recruited in the areas of cancer cell and molecular biology.

"The Markey Cancer Center is gaining increasing national recognition as a developing center of multidisciplinary excellence," says Friedell, "and the new Combs Research Facility will serve as a catalyst for future development." ■



CAN PIGEONS PLAN AHEAD?

Pecking Away at the Myth of a Stupid Bird

by Jeff Worley

In the dark compartment inside the box, the pigeon stands on the wire mesh floor. The bird faces a panel with five plastic recessed buttons, or "keys." He has been rewarded with food four times in the last few minutes, each time for remembering to peck at a previously unchosen key.

But now the pigeon is in a "delay"—this time, a seven-minute-long interval. He has pecked numbers 2, 3, 5, and 1. In order to eat,

he needs to remember to select key 4 after this delay.

The lights on all five keys finally come on. He quickly pecks number 4, and he gets to eat for a few seconds after a few kernels of grain fall into the tray.

The pigeon's ability to remember the rules of this game, especially when operating after such a long delay, is evidence of an intelligence not usually associated with pigeons,

according to Dr. Thomas Zentall, professor of psychology at the University of Kentucky. Zentall has developed this experiment, one of several which he is running concurrently with the aid of a grant from the National Science Foundation, primarily to attempt to discover what the pigeon is "thinking" about during periods of delay.

"What we're trying to determine," Zentall says, "is what might be called the pigeon's 'strategy' in this game. During the delay he might remember having made choices two, three, five, and one. Or he might remember not having made choice four yet." It's this "yet" that intrigues Zentall, since it implies that the pigeon is planning for a future event.

"It seems to us that it would be much more efficient to remember one thing that you haven't done rather than several things you have done. But thinking about what you haven't done yet is a prospective process; it's **planning** what you are going to do, and that is supposed to be strictly a human ability. The traditional view that pigeons are supposed to act only in terms of the present may be all wrong. We have some preliminary evidence that they may, in fact, be able to 'think ahead.'"

By introducing a delay under carefully monitored laboratory conditions, Zentall and graduate assistant Pamela Jackson-Smith, the lab supervisor for these experiments, are encouraging the birds to use their prospective ability. As the pigeon pecks a lighted key, so called because it functions like a telegraph key, the results of this "trial" are recorded in a separate room on a computer and the data appear on the screen. Using this information, Zentall and Jackson-Smith are then able to plot a delay function, performance based on where the delay comes and its duration during the trial.

"Typically, if the delay comes after their first choice they perform quite well. If it's after the second choice they don't perform quite as well (they make more errors) because there is more to remember. But if it's after the third choice, they don't make any more errors than after the second choice (at this point it is easier to remember the two remaining choices than the three choices already made). And, if it's after the fourth choice, they make no more errors than after the first choice (it's as easy for the



Graduate student Pamela Jackson-Smith and Professor Thomas Zentall have worked together for four years, trying to determine the memory strategies of pigeons.

“If this bird is so stupid, how is it that you can drive him to Columbus, Ohio and he'll find his way back to Lexington?”

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In a way, how clever the animal is depends upon how clever the experimenter is in asking the question—in trying to find how to present it to the animal in a way that makes sense to the animal.

pigeon to remember one key not yet pecked as it is to remember one key pecked). Although choices one and four are symmetrically located—after one it has one thing to remember and after four it has one thing to remember—this ‘one thing’ after choice four is in the future,” Zentall explains.

“This ability that the pigeons have shown us—some can remember their choices for as long as ten minutes—has been a big surprise for us,” says Jackson-Smith. “I think we’ll keep finding things like this because we begin a project by trying to imagine how the pigeon will approach the task.”

In emphasizing the importance of the animal’s understanding the rules of the task, Zentall refers to previous research in the field that he characterizes as “really badly done.” In some earlier experiments on animal behavior, an animal was typically trained to do one task, then trained to perform a second task. The question asked was, After an interval of time would the animal do task one or task two?

“This procedure does not get at what the animal remembers,” Zentall states, “but rather what the animal thinks the experimenter is asking. If you ask the animal right away, he will perform the second task because that’s what he learned last. If you wait long enough, the animal will show indifference between the two: sometimes he’ll do one and sometimes the other. He doesn’t know what you want him to do; there’s no instruction here.”

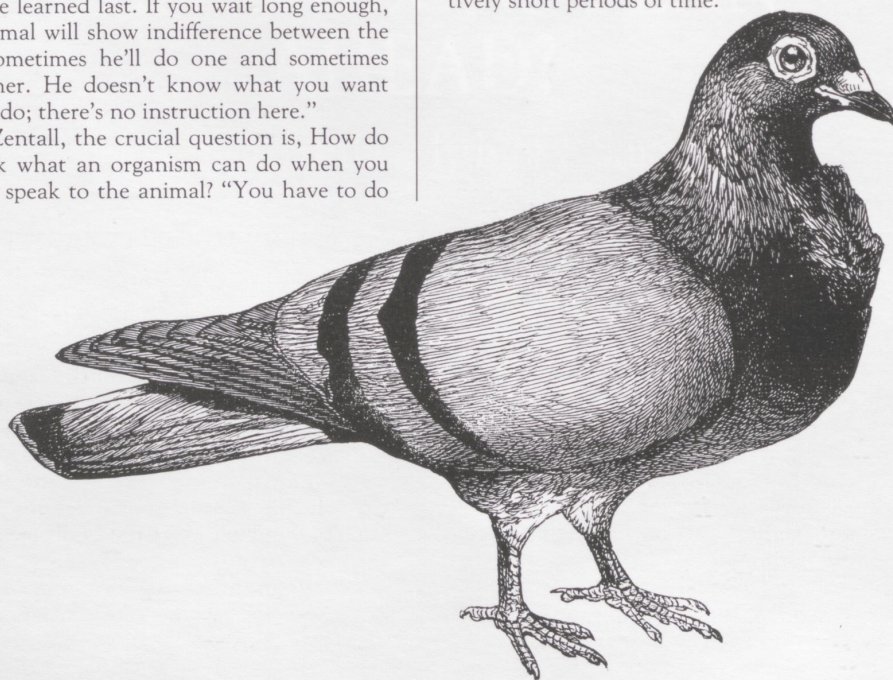
For Zentall, the crucial question is, How do you ask what an organism can do when you cannot speak to the animal? “You have to do

this indirectly,” he says, “and in a way how clever the animal is depends upon how clever the experimenter is in asking the question—in trying to find how to present it to the animal in a way that makes sense to the animal.

“Instruction,” he says, “involves understanding the basic physiological nature of the animal and being familiar with previous research with pigeons.” To take advantage of the fact that pigeons have relatively sharp visual acuity (comparable to that of human beings), either various colored hues or lines are projected onto plastic keys in the bird’s compartment.

“Pigeons have more success with hues. A hue takes up the whole field,” Zentall explains, “a field of red, for example, that’s easily detectable. The line is more discrete and seems to be a bit more difficult for them to work with.”

“One reason why we work with the pigeon is because we have had a lot of practice working with it—research using pigeons has a considerable history,” Zentall points out. He says that this foundation of research can be used as a dependable starting point in current research. He knows what kinds of tasks can be solved by the animals, and that knowledge allows him to introduce variations within relatively short periods of time.





The pigeon's regular practice with the cues designed by the researchers—the projected hues or lines, for example—is another important part of the instruction process. “These animals get ten trials each day, and some of them have been on a task for three months. They get a lot of practice trying things out. And we expect that within three months their approach should become stable—that they would develop something like a strategy,” Zentall says.

Zentall believes that patience is one of the greatest attributes that an animal researcher can have. “You need to give the animal a lot of practice so that it can understand the rules. It needs to understand that it's supposed to remember even though there is a long delay, that those original choices are important because if it pecks those same places it won't get fed. And animals, unlike humans, take a while to put these things together—they don't have any similar experiences to refer to,” he says.

A second experiment, using a different group of pigeons, is also measuring the birds' ability to plan ahead. Zentall is using a variation of the basic matching-to-sample task, in which there is a standard stimulus that provides an informational cue that tells the animal what it is supposed to do in the presence of two other stimuli. During its early conditioning, the bird learns that if it pecks at a red light on the panel, the light goes out. Immediately two other stimuli light up—a vertical line and a horizontal line. If the pigeon pecks the vertical line, he is rewarded with food; if he pecks the horizontal, he gets nothing. The bird eventually learns that, in this case, red goes with vertical and on other trials green goes with horizontal.

After the animal is able to perform this task well (several hundred trials later, perhaps), the researchers introduce a five-second delay

between the time the red light (sample) goes off and the lines (comparisons) go on. The question the researchers are asking is, What is the bird remembering during the delay?

“There are two possibilities,” Zentall explains. “One is that the bird is remembering the red stimulus it just saw. An alternative is that when he sees the red stimulus, he says to himself, ‘What I have to do at the end of the delay, is peck at the vertical line, so, during the delay, I am going to remember to peck the vertical line—instead of remembering to peck red, I remember to peck vertical.’ What's exciting about that, from a theoretical perspective, is if the animal has the ability to do that—to plan ahead, to prospect—this is a much more cognitive organism than we have given him credit for being,” Zentall adds.

In order to determine whether the pigeon is using retrospective or prospective memory, the researchers vary the duration of the delay as well as the number of stimuli used as samples. Four lights—red, green, blue, and yellow—are presented to the bird as alternatives. If he pecks red or blue, the correct choice after the delay is vertical; if he picks green or yellow, the correct choice is horizontal. The variation in the length of the delay is the key in determining what the animal is remembering.

“The more difficult or more confusable you make the sample, the greater loss of memory you should see after time if the animal is thinking back to the color of the sample—the pigeon is more likely to forget if there are four possible samples than if there are only two,” Zentall explains. “But if the animal is planning ahead, thinking only ‘vertical, vertical, vertical,’ whether there were two or four possible samples shouldn't affect the bird's memory. If the birds perform at a consistently good level, despite longer delays, we have some evidence of prospective memory—the animals predicting what's to come.”

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Zentall is obviously delighted to make one generalization from his research, even though the results are not yet conclusive: The pigeon is not a stupid bird. "Their reputation is based, of course, on human projections," Zentall says. "But if this bird is so stupid, how is it that you can drive him to Columbus, Ohio and he'll find his way back to Lexington? How does he do that if he's so stupid?"

It turns out, he explains, that the bird does this in very sophisticated ways. He uses the sun, he uses the earth's magnetic field, and he uses landmarks. "There are birds that navigate from winter in South America and find their way to a particular tree 5,000 miles north—we're talking about amazing navigational skills! And remarkable memory," adds Zentall.

In their experiments with animal memory, Zentall and Jackson-Smith use Carneau pigeons, primarily because of the birds' known genetic history and because of the convenience in getting the pigeons. "We get these birds from a breeder in South Carolina, who, we know, doesn't breed the birds for racing or for showing," Zentall states. "These pigeons are grain-eaters and are usually a bit calmer than other birds."

When the birds are first brought to the laboratory, they are given as much food as they want for approximately a month in order for the researchers to establish a stable base weight. Then the birds are reduced to eighty percent of that weight, so that they are still in very good physical condition but are hungry and willing to work.

Since the pigeons being used in these projects are given up to 100 trials a day (which can take twenty to twenty-five minutes for the bird), even if they are perfect they get only 100

feedings. This, according to Zentall, is not enough to cause them to become unmotivated. "If the bird is under eighty percent of its base weight, we will feed it up to eighty percent; if it is over eighty percent, we will not give it any additional food." Each bird is weighed after each set of trials so that this determination can be made.

Zentall's interest in animal behavior developed during his graduate school days at Berkeley. He remembers a "very strong program in human learning," in which researchers used a "pair associate" task approach to study human memory. Pairs of items were studied until they were remembered; then the researchers focused on how memory was transferred to new pairs, how the association between stimulus and response developed.

"I became interested in asking the same types of questions in working with animals," Zentall says. "My dissertation was in the area of animal memory. I was interested in what events animals could remember."

This interest is shared by Dr. Peter Urcuioli, professor of Psychology at Purdue, who is the Co-PI in this current project. When, on a recent sabbatical, Zentall met Urcuioli, they discovered that they had similar research interests and so decided to write a grant proposal together. "This is a little unusual," Zentall admits, "to go cross-universities, but we decided we were doing such similar work and could work well together that we would go ahead and do it." The grant was awarded to Zentall and is on a sub-contract at Purdue. The two researchers talk frequently and meet to compare notes every two or three months.

Does Zentall see any potential applications of this research to the human animal? "It's tough to make direct analogies between how you can instruct an animal and how you teach a human being to do something. There are some people, though, who have taken the kind of research we do and used these techniques to work with learning-disabled or retarded children. Animals obviously have no verbal ability at all, but we get them to perform at levels that surpass what we thought they could do. Perhaps some of these techniques can be used to assess and train children, or even adults, who have learning problems. ■

COUNTRY PLACES, FORGOTTEN SPACES:

Images of Japan and Kentucky

Photographer Linda Butler says that in Japan it is common practice to display photographs of one's ancestors in a small shrine at home. The tradition, she says, grows out of a respect for history and a love of family.

In Scott County almost every farmhouse, whether hugging a 4-lane blacktop or isolated among hickories and white oaks, will have a similar "shrine" above a fireplace mantel or along a bedroom wall—parents, grandparents, great-grandparents . . . faces that take us back to another century.

In 1986 Butler, with the assistance of a grant from the Kentucky Arts Council and the Kentucky Foundation for Women, set out to capture the spirit of the land in Scott County before it was to be dramatically changed. A few months later, she made her first of two trips to Japan, where she explored traditional country villages and homes.

Some of Butler's work that resulted from this trip will become a permanent part of the University of Kentucky's Special Collections and Archives, according to Mr. Bill Marshall, assistant director of libraries for special collections and archives. "I saw Linda's book, *Inner Light: The Shaker Legacy*, a couple of years ago and was impressed by the artistry and historical undertones of the photographs," Marshall says.

He met Butler at the Frankfort Book Fair last year and asked her if she would be interested in placing some of her work with the UK Archives. Several of her finished photographs, copy prints, and proofs are now part of the Archives collection. Marshall explains that although the work belongs to the university, Butler still holds the copyright and has control over how the photos are used.

He stresses the historical significance of her work, saying, "Linda's photographs compare favorably to those of Doris Ullmann [whose work is also part of the Archives], who accompanied John Jacob Niles through Appalachia in the late '20s and '30s. Butler's photographs are very important historically."

Even though Butler made no conscious effort to match images from the rural Japanese and Appalachian cultures, some astonishing similarities emerged later from the work. It is these subtle associations that have shaped Butler's current exhibition titled "Connections: Japan/Kentucky."

The Kentucky photographs were taken within a 20-mile radius of Georgetown. The images remind us of a bygone era when land was cheap, when a family's livelihood depended on hard physical labor, and needs were simple.

These were a few of the quiet, forgotten spaces of the Kentucky countryside before the bulldozers came, before the land was flattened and blacktopped. About half of these photographs were shot on the property which is now the site of the Toyota factory.

The Japanese photographs were taken in country towns far from cities buzzing with high-tech industry, metropolises for which Japan is largely known. In contrast, Butler's photographs show us abandoned homes, the natural textures of wood and straw, and farmers hard at work.

In her pairing of photographs, similarities between the cultures are evident as are extraordinary differences. It is the eye of the photographer that ultimately binds these two cultures together—isolating a moment in time and space, preserving it, and allowing us to re-claim it.

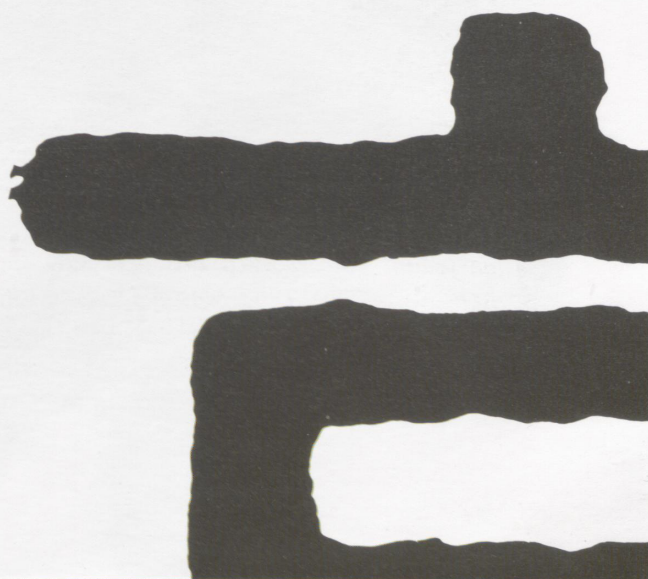
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The tenant who worked this field said the tobacco leaves grown here during the 1985 season were as tall as a man. This abandoned house and adjoining field were leveled in preparation for construction of the Toyota plant.



Because of the value of arable land in Japan, every available inch is cultivated. Often the fields are terraced and extend into mountainous regions. The 'grandfather' in the foreground is planting a small vegetable garden just ten feet from a highway which adjoins Kyoto and Nara in central Japan. The long 'rolls' of plants in the background are tea bushes. 'New' tea made from the present year's crop is considered to have a special aromatic flavor and hence is a particular delicacy.





***T**wenty years ago, a large home near Georgetown was abandoned with many of the objects left intact. A grandchild's photo, hung next to the fireplace mantle, is still in place despite the slow deterioration of the rest of the house.*



This peeling Buddha was located in the courtyard of a Zen temple in central rural Japan. Appearances would indicate he is largely forgotten and neglected, yet someone recently had thought to bring a vase of fresh iris.



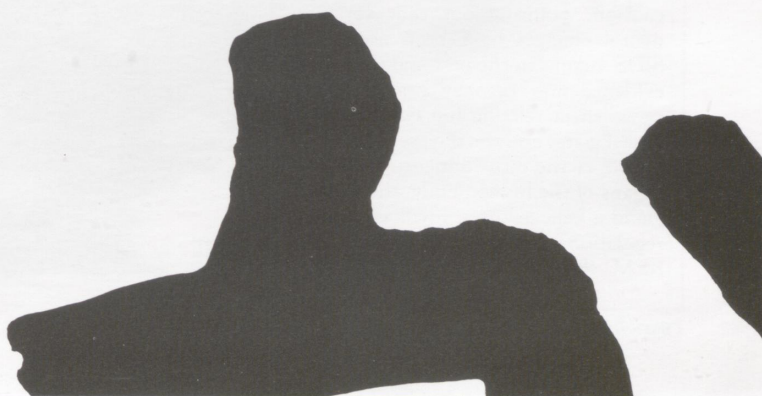


The curved glass protecting this couple's portrait catches the reflections of a window on the opposite wall of this old house outside of Georgetown.



Found in a Buddhist temple in Northern Japan, these photos are remembrances of deceased relatives. It is common practice to have photos of one's ancestors in a small shrine at home, but it is unusual to see a group of photos such as these in a temple.

Ms. Butler's photographs will be on exhibit at the Peal Gallery of the University of Kentucky's King Library from February 28 through March 31st, 1988.



RESEARCH BRIEFS

A Clue to Sudden Infant Death Syndrome

Preliminary data compiled by two UK Chandler Medical Center researchers indicates significant physical abnormalities in infants that have died of crib death, or Sudden Infant Death Syndrome (SIDS).

Dr. D. Larry Sparks, assistant professor of neurology at the UK College of Medicine and chief biomedical consultant for the Kentucky Medical Examiners Office, and Dr. John C. Hunsacker III, assistant professor of pathology at the UK Medical Center and associate chief medical examiner for Kentucky, recently announced their preliminary findings at the annual convention of the American Academy of Forensic Sciences.

Comparative autopsies of 17 SIDS and 14 normal infants reveal statistically significant macro- and microscopic differences in the pineal gland. In all of the 31 case studies, the most obvious difference is the average size of SIDS infants' pineal glands, which are about 60 percent smaller than the pineal glands of normal infants.

SIDS is defined as the sudden, unexplained death of an apparently healthy infant. It is the most frequent cause of death in infants aged one month to one year. To date, there has been no specific physiological abnormality to identify a SIDS victim.

Members of the UK research community have expressed optimistic caution, pointing out that various neural changes have been noted in SIDS victims in the past and that this evidence may or may not prove a cause/effect relationship between the pineal gland and the disease.

One of the most underinvestigated organs of the human body, the pineal gland is believed to be involved in the regulation of body temperature and REM (Rapid-Eye-Movement) sleep

cycles. Investigations suggest that pineal-specific melatonin, a hormone that produces a lightening of the skin, also induces REM sleep, which is believed to protect SIDS-susceptible infants.

Remarkably similar alterations have been noted in SIDS infants and in animals that have had their pineal gland surgically removed, as well as in hibernating animals (during which time the pineal functions are suspended). Similar abnormalities have been noted in EEG-recorded sleep, temperature regulation, increased body temperature, the adrenal glands, and the retention of brown adipose, or fatty, tissue.

With Sparks and Hunsacker's findings, medical examiners may have a potential method of diagnosing SIDS deaths. The UK researchers' methodology is already being used by medical examiners in laboratories across the country, and results are being shared.

-Gail Green Hairston

Using "The Plague" to Battle Other Diseases

Amidst state-of-the-art technology in a modern tertiary care center, Dr. Susan Straley of the Department of Microbiology and Immunology studies a disease which, centuries ago, terrorized a continent. Scientifically classified as *Yersinia pestis*, the disease is more commonly known as "The Plague" or "The Black Death."

During the peak years of its reign (1347-1351), between 17 and 28 mil-

lion people died, with the mortality rate in some cities as high as 60 percent. Today, The Black Death can be vanquished with antibiotics tetracycline, streptomycin, and chloramphenicol.

Although no longer a major health concern, plague still exists. "It's in desert animals," says Straley, "and is transmitted by their fleas. Actual occurrence of the disease is minimal, but it is still around, and at least 10 to 20 cases of bubonic plague occur annually in the United States." Straley explains that most of the individuals stricken with plague today are hunters. "They may, for example, have a scratch or cut on their hand and become infected with the disease while skinning an animal," she says.

If the disease has been effectively tamed, why does Straley study it? "When I entered the field, I chose to study plague because more was known about the virulence properties of that particular pathogen than of any other bacterial pathogen. Now, a few other pathogens are as well understood as *Y. pestis* and offer their distinct clues as well. Although we still don't understand how these virulence determinants actually work, we can home in on them and measure them in the laboratory. And what we learn about their 'talents' and their vulnerabilities could open doors in studying other lesser-known pathogens."

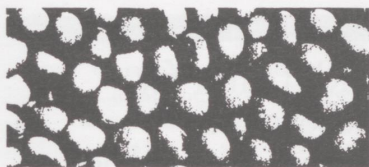
Straley explains that our current understanding of infectious diseases is "really very rudimentary." "Antibiotic therapy is limited in its effectiveness and flexibility by the degree of antibiotic resistance that the pathogen develops," she states. "It would be helpful to have a new, totally different approach to treating bacterial infections."

"If we can understand how the bacteria invade the body—how they turn on or shut off the particular gene expression that activates or deactivates their defenses—we can develop new strategies of treating infectious diseases. Even if we cannot destroy the bacteria, if we can at least cripple their virulence determinant, we will have an edge."

-Sandra Gray Thacker



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Newspapers Go to Beans

If results of early tests of soy oil-based inks hold up, newspapers may soon be covered with good news for soybean farmers—literally.

A recent issue of *Editor & Publisher*, a trade magazine of the newspaper industry, reported that test runs using inks made with soy oil have produced newspapers of a quality "equal to and maybe better than" petroleum-based inks, according to Mr. Lon Myers, operations director of the *Cedar Rapids Gazette*.

James Herbek, extension grain specialist in the UK College of Agriculture, says that a bushel of soybeans will yield 10 to 11 pounds of oil. Continued high performance of the soy oil-based inks on the newspaper presses could open a 30-million-plus bushel annual market for soybean farmers.

UK's Chien Takes Nation's Lead in Organ Viability Research

The UK Chandler Medical Center is taking the lead in auto-perfusion research to extend the viability of organs retrieved for transplantation.

Dr. Sufan Chien, assistant professor of cardiovascular and thoracic surgery in the UK College of Medicine, has extended the longevity of animal organs up to 40 hours in his laboratory. Under normal circumstances, hearts and lungs remain viable for transplantation only about four to six hours in auto-perfusion, limiting and complicating transplant possibilities.

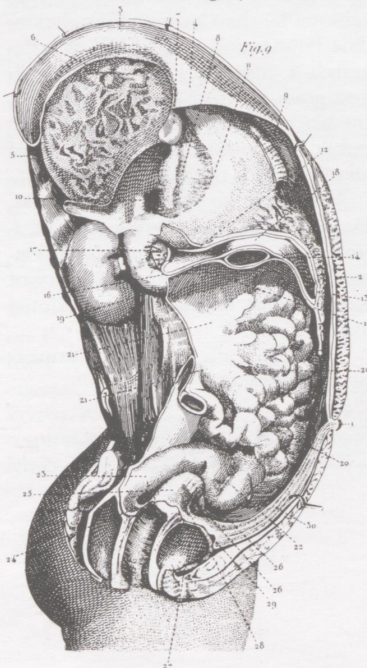
"In our research we are now using pigs because their internal system is anatomically close to that of hu-

mans," Chien says. He has developed two procedures which sustain functioning vital organs outside the body. One maintains the biological link of the heart, lung, and one kidney, preserving the viability of these vital organs for an average of 24 hours.

A second procedure preserves viability for an average, also, of 24 hours by maintaining the link with the heart, lung, both kidneys, liver, pancreas, and part of the intestine. In this procedure blood vessels and arteries remain connected, and the organs continue functioning throughout the procedure. "There is no tissue damage at all," Chien states, "if the operation is done carefully."

At least three other research teams in the United States—in Pittsburgh, Cleveland, and Minneapolis—are conducting similar research, but Chien's methodology has resulted in a higher success rate for much longer periods of time. The other researchers' viability averages range from seven to 11 hours.

"Dr. Chien is at the very frontier of this important research. He has doubled the best longevity results others have been able to produce," says Dr. Edward Todd, professor of cardiovascular and thoracic surgery.



Dr. John Diana, associate dean of basic sciences and research in the College of Medicine, says, "We have great hopes for Chien's research. Someday we may be able to maintain human organ banks within major hospitals, eradicating the emergency nature of such procedures and allowing time for exhaustive tissue matching."

That "someday" may be one day soon. Clinical transplant procedures are advancing at a rapid pace, as evidenced by a recent heart, lung, and liver transplant in England. The details of this operation were presented in the October 1987 issue of *Surgical Practical News*, under a headline announcing that the Multi-Organ Transplant Age Has Arrived.

If this new "Medical Age" is here, Chien has played a significant role in hastening its arrival.

-Gail Green Hairston

An Aspirin a Day to Keep Stroke at Bay? UK Part of National Study

The UK Chandler Medical Center is one of sixteen medical centers that are currently involved in a major national study to determine whether a popular operation is more effective than aspirin in preventing strokes. The five-year study is supported by an \$11.6 million grant from the National Institute of Neurological and Communicative Disorders and Stroke.

Dr. Byron Young, professor and chairman of the department of surgery, is the principal investigator at the UK Chandler Medical Center of the Asymptomatic Carotid Atherosclerosis Study (ACAS). Dr. Michael P. McQuillen, professor and chairman of the department of neurology, heads the team of neurologists.

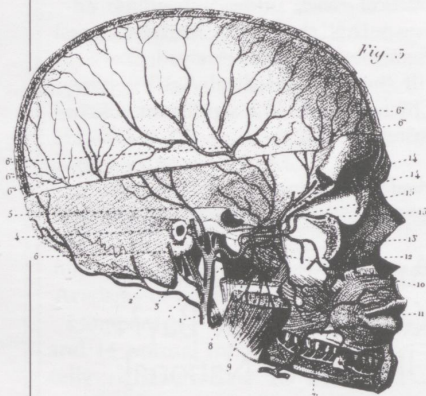
This study is restricted to 1500

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patients who have a significant atherosclerotic narrowing of the carotid artery, which supplies blood to the brain, but who have had no stroke symptoms, not even the temporary or minor strokes that doctors call transient ischemic attacks, or TIAs.

Since the late 1950s, endarterectomies—surgical removals of the inner layer of an artery when thickened—have been performed in patients with or without symptoms of strokes or impending strokes. But many physicians have questioned whether the operation, which carries some risks, is better than medical treatment for the same conditions.



There has never been a carefully controlled national study of endarterectomies on patients who have narrowing of the carotid with no symptoms. In the ACAS study, by random selection half the 1500 patients will get an endarterectomy and half will not. All will take a daily aspirin because aspirin has an anticoagulant effect known to help prevent blood clots that could plug the carotid at its narrow points.

According to Young, the study seeks answers to two questions: Will the surgical procedure reduce the incidence of transient ischemic attacks and strokes significantly more than aspirin alone? If so, does the reduction in the numbers offset the rate of complications resulting from the surgery to a great enough extent to justify the procedure?

In addition to answering these major questions, the ACAS will be looking at a number of side issues, such as

the relative effectiveness of several different tests for detecting the narrowing of the carotid. They will also be evaluating the effectiveness of the CAT scan in finding brain damage after a stroke has occurred and in spotting possible unreported strokes.

—Mary Margaret Collier

Faculty Awarded Over \$48 Million

UK faculty were awarded over \$48 million in grants and contracts during the 1986-87 fiscal year. These are funds from federal, state and extramural agencies for projects to be carried out by the faculty. Private gifts and grants are not included in this amount.

Of the awards received, nearly \$30 million was for research projects, \$6.7 million for instruction, \$9.8 million for public service, and \$1.6 million for other projects. Faculty compete nationally for the awards through stringent review processes.

An indication of the UK faculty's strength in securing funding was demonstrated in the university's recent ranking by the Carnegie Foundation. The Foundation ranked UK as a Research I university among research and graduate institutions. This ranking places UK in a class of the top 45 public institutions and the top 70 of all institutions in the United States.

According to UK President Dr. David Roselle, "The ranking is a measure of potential for future development. We look for the University of Kentucky to develop as a 'national university.'"

UK is the only Research I university in Kentucky.

UK's Center for Robotics & Manufacturing: Lasers, "Sloppy Joes," & TV

The University of Kentucky may soon become a leader in the field of robotics. The new Center for Robotics and Manufacturing Systems, scheduled for completion by April of 1989, is funded as a center of excellence and will highlight the state's efforts toward both excellence and economic development.

The primary objectives of the center will be to conduct graduate-level academic research and to reach out to industry across the state to transmit knowledge gained through research. In addition, the center will house a continuing education and extension activity whose primary purpose will be to assist all state industries.

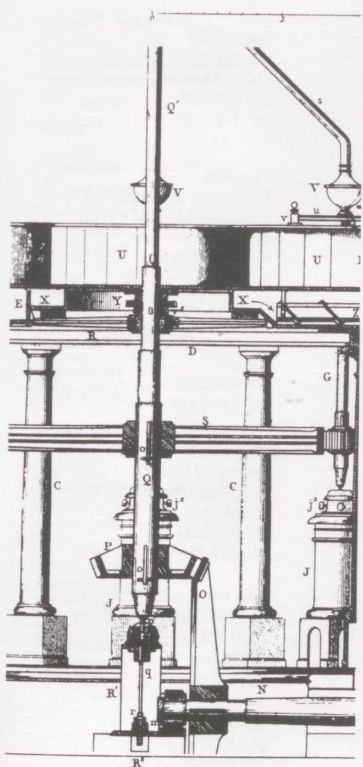
One of the important functions of the center will be to help small businesses improve their competitive positions by using the latest technology in robotics and manufacturing systems. UK's first two extension engineers, Dr. Roderick Heard and Mr. Alvin Wittwer, will assist Kentucky industry in a way similar to that of the long-established agricultural extension agents, who respond to public calls for agricultural information. Heard, who has an advanced degree from Stanford University, brings 27 years of industrial experience to this new position. Wittwer received undergraduate and graduate degrees in Mechanical Engineering from UK. He served as project engineer at the Wenner-Gren Aeronautical Laboratory prior to 27 years of subsequent experience at IBM.

Working out of their renovated offices in the Slone Building, Heard and Wittwer have already become familiar faces to many of those who operate small businesses in central

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Kentucky. "To make more people aware of our existence, we have made a series of promotional videos that highlight local industry," Wittwer says. "We go to a businessman or businesswoman and say, 'What do you do, what do you make?' We then have UK's Instructional Resources film crew come out and make a video for the company, a 90-second spot that is aired across the state. Dr. Roselle introduced the series by highlighting Whirlpool in Danville. The reception has been terrific," Wittwer adds.

Wittwer says that part of his job as a liaison to industry is to put people in contact with one another. "I was talking with a guy two months ago in Owensboro who badly needed a small laser that could weld stainless steel pieces together. I put him in contact with a vendor who made him one with the power to split laser light into three different stations," Wittwer explains.



"It's been a learning experience for me as well," he admits. "I found out, for example, that there's a textile plant not far from Lexington that makes 'Sloppy Joes.' No, not hamburgers—sweat suits! The plant can't make them fast enough it's such a successful item; they asked our advice on how to speed up their manufacturing process."

Such services are available without charge and can be requested by telephoning toll free (from within Kentucky) 1-800-2 A ROBOT.

Developing a More Effective Drug to Combat Seizures

Pharmacy professor Pankaja Kadaba has made a discovery that could lead to the development of a safer and more effective drug to control seizures. The discovery? The catalytic property of water.

In studying the chemistry of triazoline, Dr. Kadaba in recent years has been focusing on how to make anticonvulsants in the gram quantities needed to test these compounds. "I found that water—plain old water—catalyzes the reaction," says Kadaba. "Suddenly it was possible and easy to make gram quantities of the compound." Studies in Kadaba's laboratories have led to the emergence of triazolines as a new generation of anticonvulsant agents, and the researcher holds several patents on the triazolines.

Kadaba says that although there are several good anticonvulsant drugs on the market today, many of them have bad—sometimes toxic—side effects. "Dilantin, for example, is known to cause bleeding in the gums, respiratory problems, and liver problems. And drowsiness is a common

complaint of people who use Dilantin," she explains.

She also mentions that with drugs now available on the market, not all seizures can be completely controlled. "There are three types of seizures—grand mal, petit mal, and complex partial—and this third type is the most difficult to control," Kadaba says. "Dilantin does not effectively control complex partial seizures; from tests that have been done using animals, triazoline seems to be much more effective."

Kadaba says that preliminary toxicology studies—90-day tests—have been done on two different animals (a rat and a dog) and that she would like to begin clinical testing of the drug. "Money," she says, "is the stumbling block. You have to have a lot of money for clinical testing, so we need a sponsor. We're now in the process of finding an interested drug company." Kadaba believes that many drug companies might hesitate to fund such clinical testing because "there's not much money in it." She says that even though there are over four million Americans who have seizures, this is a small market compared to those who need heart drugs or cancer drugs.

Kadaba is continuing her study of the metabolism and pharmacology of triazoline anticonvulsants with the assistance of a three-year grant from the National Institute of Neurological and Communicative Disorders and Stroke.

Jeff Worley

(Sources for Research Briefs include *Colloquium*, *The Ambassador*, and the OSPA/UKRF 1987 Awards Tabloid)

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