Dr. Chris Lee

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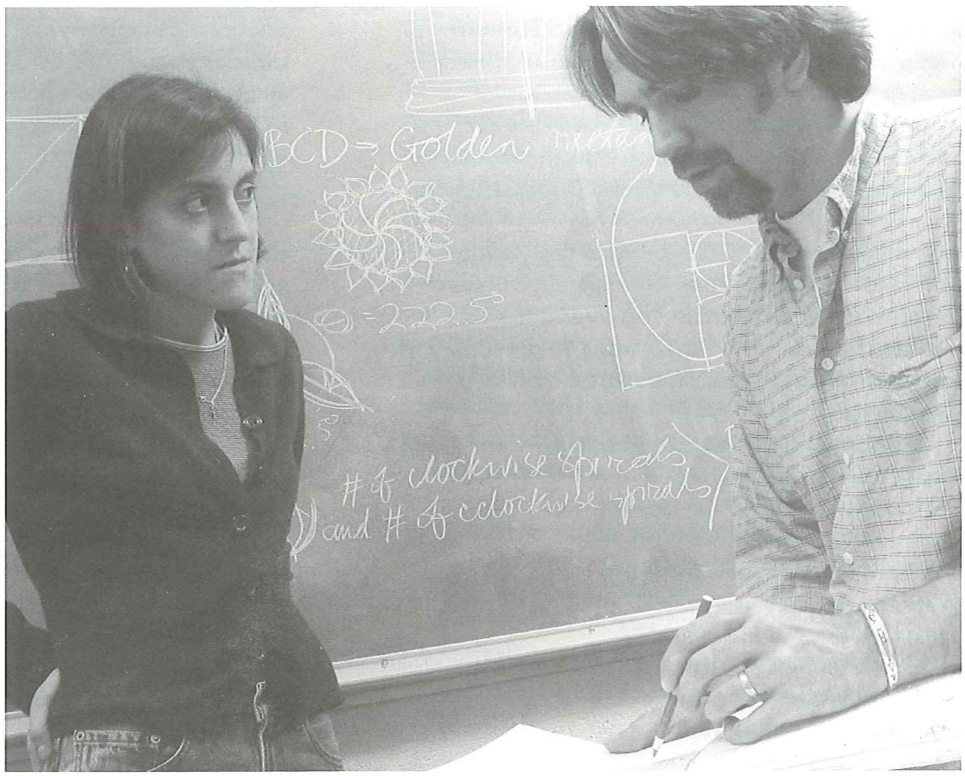

RC student Yulia Romaniuk '00 and Dr. Chris Lee explore the magic of the "Golden Ratio," a physical proportion that occurs in both nature and art and is thought to strike the perfect balance between large and small.

The magic in numbers

IT'S A NUMBER, APPROXIMATELY 1.6, simple on the face of it, but extremely complex in its uses. It's a proportion, thought to strike the perfect balance between large and small. It's the "Golden Ratio," a concept that intrigued Roanoke College student Yulia Romaniuk '00 and led to a 73-page Summer Scholar project that her adviser, Dr. Chris Lee, calls "very well put together." It also led to intense student-professor interaction.

"I've always liked Dr. Lee's teaching style and his enthusiasm," Yulia says, "and he strongly encouraged me to pursue this research opportunity. He helped me tremendously by directing me to the right sources, evaluating my research and giving me great ideas. One of the best things was working one-on-one with an excellent adviser, getting to know my teacher on a different level than just an instructor in class."

Originally, Dr. Lee explains, Yulia was worried about getting enough good material for her project. "It was hard at first to convince her that's not the only outcome. The outcome is that she learns to research something, to dig and create thoughts and tie the stuff together. Whether or not it is actually impressive mathematically is only a side issue."

Outcomes and applications are the main focus of this Roanoke College associate professor of mathematics. They fit neatly into his background as an applied, as opposed to a theoretical, mathematician. "My adviser put it well," he notes wryly, "There are

enough problems out there; there's no reason to create new ones. That sums up applied math." In his work with students, Dr. Lee not only shows them ways they might use math in a career, he sometimes manages to get them directly involved.

For instance, when he first came to Roanoke College he was working in his particular research area, neural networks, through a grant from Grumman Aerospace and Electronics. Dr. Lee was able to get one of his math students written into that grant so he could receive practical experience on a real world problem. "One of the things I like about Roanoke College is that the College always asks, in reference to my research, what the benefits will be to students," he says. In this case, the benefits were obvious. Showing students the real life value of mathematics is a subject dear to Dr. Lee's heart.

"Students ask me what they could do with a math major. I say to them, 'Here's a problem, involving neural networks, that you could work on. I've been working on it for five years and haven't solved it yet.'" He adds, "Even in lower level courses, anytime I can base the mathematics on a real world example, I have much more success with students hanging on and really understanding it and saying, 'Well, ok, maybe I should learn that.'"

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Learning to Learn

Dr. Lee adds, "Admittedly there's some theory students will have to know. I tell them that they're learning to learn, and they need the underlying theories." He says that his classes are about equally split between males and females, but that the majority of the best students are women, probably because they're more serious about the subject.

Dr. Lee earned his B.A. in mathematics at St. Olaf College in Minnesota and his M.S. and Ph.D. in mathematical sciences from Clemson University. He was a teaching assistant at Clemson and a visiting assistant professor at John Carroll University, prior to joining Roanoke College in 1994.

A Family of Teachers

"I grew up in a liberal arts environment," he says, explaining that his parents and his stepparents teach at St. Olaf and the teaching profession strongly appealed to him. "When I was looking for a job, I wanted a lot of faculty-student interaction, small classes, and the chance to teach a wide variety of courses. Roanoke College was exactly what I was looking for.

"Unlike some other colleges, Roanoke already had set up meetings with students for me when I came to interview. They knew that would be important to me, and I was struck by that." He adds, "The faculty atmosphere was also impressive; everybody seemed to have fun, to get along and to enjoy teaching. It wasn't cutthroat; nobody was worrying about one-upmanship."

Also, the geographic location was inviting to someone who'd never set foot in Virginia before, and the opportunity for outdoor activities appealed greatly. These days Dr. Lee and his wife live on a horse farm and raise Appaloosas. He does some trail riding, shows horses, and serves on the board of directors of the Shenandoah-Blue Ridge Appaloosa Horse Association.

Equestrian affairs are quite a change from neural networks, which he describes as computer scientists' and mathematicians' attempts to model how the human brain solves a problem. "We're born with all these neurons and synapses and they're fairly random, but as you learn, the connections become more solidified," he explains. "A neural net is a programming function where you have a problem to solve and you train the program to solve the problem by showing it examples and letting it learn."

Connecting the Dots

As an example, he points to radar tracking of non-commercial aircraft, an area he worked on for Grumman. "The E-2 AWACS plane has a radar dish on top spinning around every 10 seconds, and you're getting two to three thousand radar blips every time it spins around. An aircraft appears on a radar scope every 10 seconds and you have to decide which airplane is which blip. So what you have is a fantastically complicated game of connect-the-dots.

"You're trying to detect tracks among all these radar returns, all these variables. So you take all these measurements and feed them into a neural network. You say, 'here's the input and here's the desired output,' and you train it over and over; if the computer's answer is wrong, you tell it so, and it goes back and corrects it. You do this repeatedly and the neural

network learns what connections to use. It's a pure learning process, in a sense."

He says that neural networks are used in many industries, including banking, and are particularly good at speech and visual recognition. His work in the field of neural networks resulted in a patent on their design and digital implementation, based on work he did with two colleagues.

Dr. Lee teaches both upper and lower level math courses, including differential equations and applied math. "You're looking at real world problems and asking how we come up with equations that explain them. You get into mathematical modeling, population dynamics, modeling populations of species and what we can learn from that." He's also taught discrete math. "That's the logic courses, the proof theory courses — how do you prove something's true, what does it mean to say that a statement's false, why does alibi work?"

Not Your Father's Math

The latter is a wonderful course to teach, he says, a lot of fun. "It's not mathematics like the students have seen before, where the answer is 12. It's very different. Most of the students are freshmen and a lot of them think about calculus when they're thinking about whether to major in math. I try to get them over that. No one does calculus for a living. It's a building block, like vocabulary is for a foreign language."

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— Dr. Chris Lee

Dr. Lee also teaches non-math majors, "the students who say that they hate math." Every Roanoke College student is required to take some math. He finds teaching non-majors a challenge. "It's become socially acceptable to say you can't do math. If you tell someone you can't read, they say, 'My gosh, a failure of the educational system.' If you dig a little bit, you normally find that students' dislike of math isn't because they tried it and couldn't do it, it may be because their parents didn't like it either, a generational thing, or just because it's ok not to like it.

"It's a real struggle to convince students they can work through it. Like many schools, we've decided to teach non-majors contemporary math, things like game theory, voting theory, things they can get a handle on. In some ways, the mathematics isn't as hard in the sense of number crunching, but the ideas are harder, trying to understand the problems and knowing what to do."

Learning by Doing

Dr. Lee adapts his classroom style accordingly. "I try to stay as far away as possible from the standard, 'I'm up here lecturing and you're down there madly scribbling notes,'" he says. "I give students handouts containing math problems and break them into groups to work through them. They may not know it, but they're working through a problem and learning through trial and error. Eventually I'll go to the board and show them they just worked their way through a problem in calculus."

He adds, "It gets them talking with each other and helping each other, which builds relationships in and out of the classroom. And once they're talking together, they're more likely to talk with me, have a dialogue."

In addition to his heavy course load, Dr. Lee is very active in scholarly service to the community, speaking to local junior high and high schools, talking about careers in mathematics. He's frequently a judge for science fairs in the schools and also helps judge the Science Olympics that Roanoke College annually sponsors on campus.

Technology has made learning easier for some students, he says. Each student is required to buy a calculator, and the school has a number of math labs equipped with sophisticated software to handle complex problems. "In differential equations we used to spend a lot of time focusing on all the nitty gritty steps in solving the problem," he says. "We still need to know that, but with the calculator, we don't have to spend 30 minutes on those steps. We can spend that 30 minutes interpreting the results, and dealing with questions like, 'now we know that, what does it tell us?' We work very hard to make sure the calculator is a tool, not a crutch."

Dr. Lee's enthusiasm for his subject is contagious. "When I teach theoretical material, students sometimes say, 'gee, will I ever use this?' And I'll tell them, "Maybe not directly, but you'll use the skills in reasoning through a problem and solving it. That's the bottom line in all this — the exhilaration of working hard on something and getting an answer.

"To me, mathematics is all about problem solving. It's critical thinking, how to reason through a problem and solve it, and how to interpret the results, which is just as important.

"That's why I like to get students into courses like discrete mathematics, with the logic and proofs and some of the interesting applications. It lets them know a lot more about what mathematics is really like."