Dr. Roland Minton
and the calculus book read around the world

Dr. Roland Minton, professor of mathematics at Roanoke College, tells his freshman students that math is the best general-purpose major on campus. "When the laughter dies down, I remind them that employers want people who can learn quickly, solve problems, think abstractly and see connections among ideas," he says. "Those are all math skills, and they're critical in our modern technological society."

Minton believes that mathematics courses done well are perhaps the purest mental conditioning programs humans have devised – and he should know. With co-author Dr. Robert T. Smith, professor of mathematics and chairman of the Mathematics Department at Millersville University of Pennsylvania, he has produced a textbook, called *Calculus*, that draws rave reviews from users.

A mathematician using the book at the University of Nebraska says, "I believe that Smith/Minton will become one of the leading calculus texts in the near future…. It is more popular among the faculty than any book we have used in the past. It has the best problem sets of any calculus book."

Calculus is being used in 100 colleges across the U.S., including Roanoke College, and on every continent except Antarctica. It was designed to be something that students actually enjoy reading, not just an encyclopedia of facts. It provides challenging writing exercises in every section, offers a wide variety of problems, integrates technology within the text and serves the whole thing up in a highly readable, conversational style.

"The writing exercises are my favorites," says Aleah Dillon, one of Dr. Minton's students. "They require a well thought-out proof and take you through an entire problem from beginning to end. And he uses real-world examples to explain what's going on, like tying it to sound waves, for instance, or analyzing what happens when a ball drops."

"Ours was the first text to use writing exercises," says Dr. Minton, who produced all of those in the book.
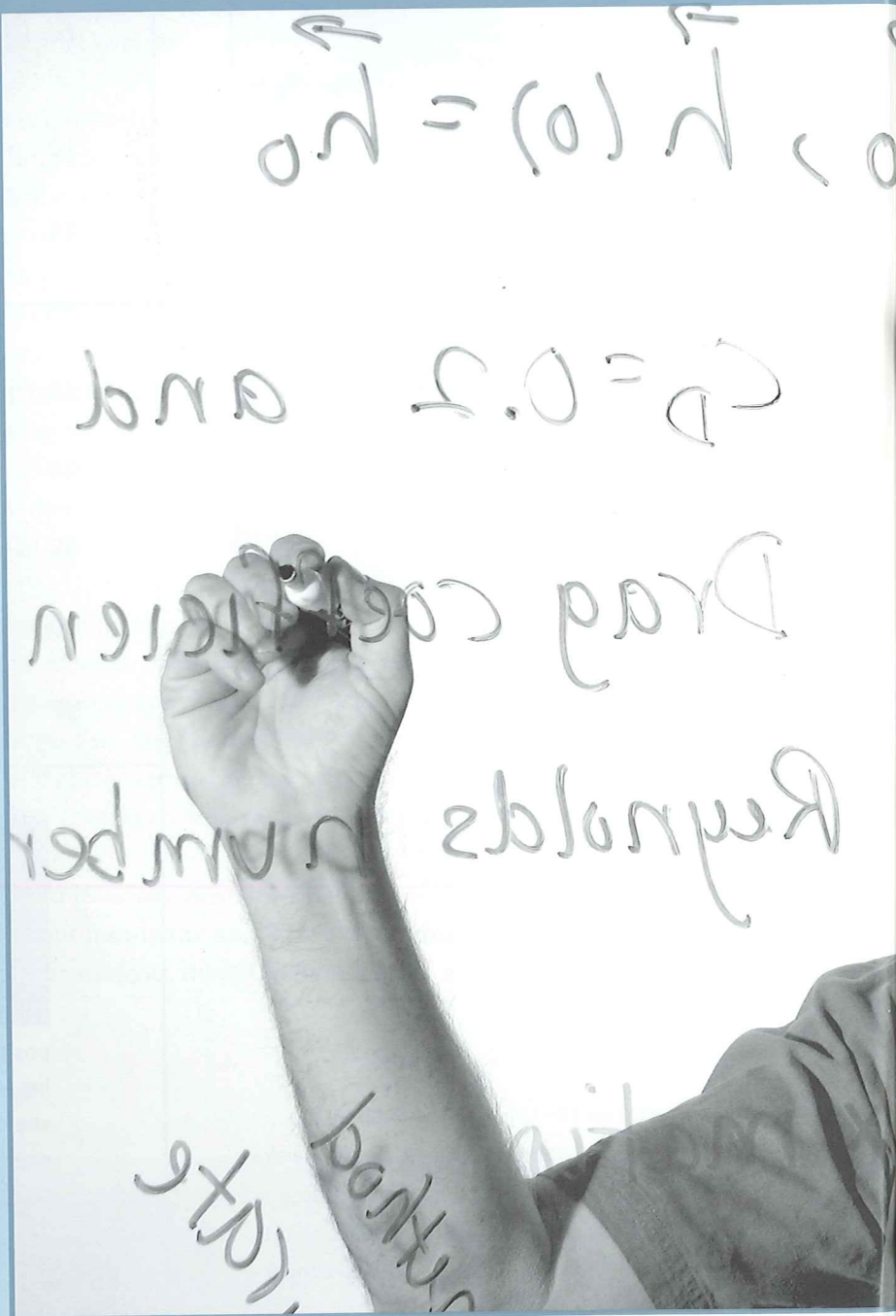
"Students might feel the whole point is just to end up with x=y. But there's a lot of theory I want them to understand, and writing exercises are a great way of doing that so they really understand the problem, not just how to do the calculations."

"I tell beginning calculus students, 'Try these five things on the calculator and look at the answers and tell me what pattern you see. Try to put into words as much as possible what that pattern is.' If they do it well, which most of them do, what they've done
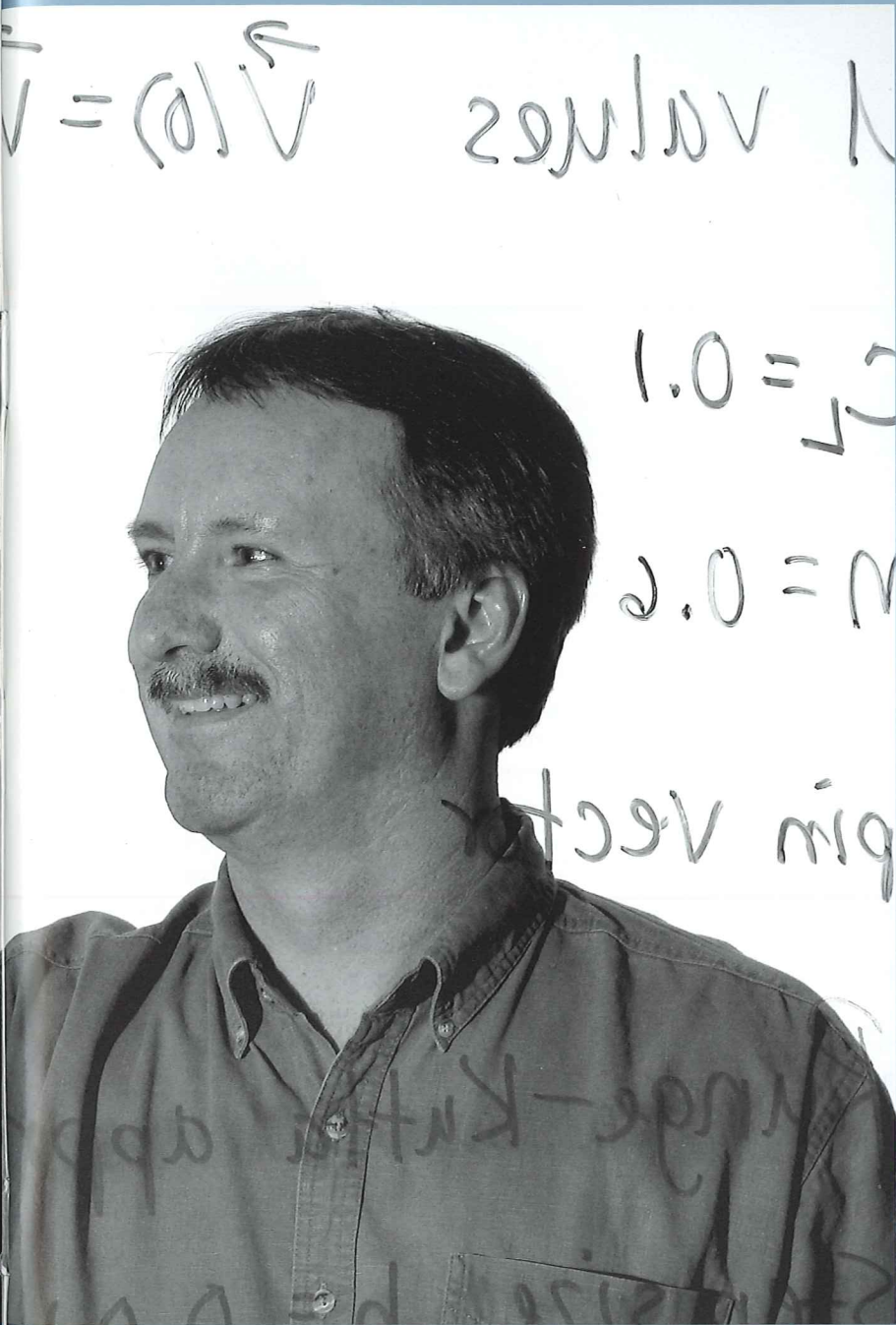
who's not. That's a horrible way to teach calculus."

One of the first battle cries of the reformists was "a pump, not a filter," he says. "Instead of filtering students *out* of math and engineering, we want to get them excited about math – pump up their interest." His text follows the traditional order of topics but pulls some good ideas from reformists, like writing exercises, group work and extended projects.

Compiling the book was a massive task since it contains some 70,000 problems and 1,000 examples. For the authors, it's the culmination of 10 years of effort producing a series of calculus-related texts for McGraw-Hill. The first edition of *Calculus* appeared in 2000; this second edition in 2002, and there's also a Spanish version. The authors are working on an alternate edition, which will provide a re-ordering of topics for teachers preferring that approach.

Working on the book was an exhausting task but didn't noticeably detract from Dr. Minton's teaching – he won the College's coveted "Exemplary Teaching Award" in 1998. Last fall, he taught Calculus I and its accompanying lab, along with Real Analysis, which he describes as looking at "the nitty gritty details of calculus theory – not just learning how to do the calculations but understanding how all the theories interact and connect with each other."

The lab is new and helps students do some assignments in groups, like the "Homework Projects" assigned during the semester. There are usually six of them, each taking about a week. "We do some of them in the lab, as a group, and find out what works and what doesn't," Dr. Minton says. "There's nothing in the book exactly like them, so students have to think about them and ask questions. It's hard work; it's trying to get them thinking a little bit on their own." Encouraging students to do their own thinking is a continuing effort. "We try to wean them from a lot of dependence. The ideal is for students to do the work themselves, but the question is, what's the best way to take them from where they are now and get them closer to that ideal," he says.

is discover a nice piece of theory," he says.

Another thing that's different about *Calculus* is that the text synthesizes two schools of thought in calculus education – the traditional and the reform movements.

Dr. Minton says traditionalists sometimes use calculus as a "filter" for weeding out students. "At some engineering schools, calculus professors would flunk a quarter of their students," he says, "which would tell them who's going to be an engineer and

Dr. Minton has a knack for making calculus interesting by relating it to things that capture students' imagination. Many of the examples in his text are sports-related since, he says, both sexes know and enjoy sports and equal numbers of men and women take his courses. "You don't have to d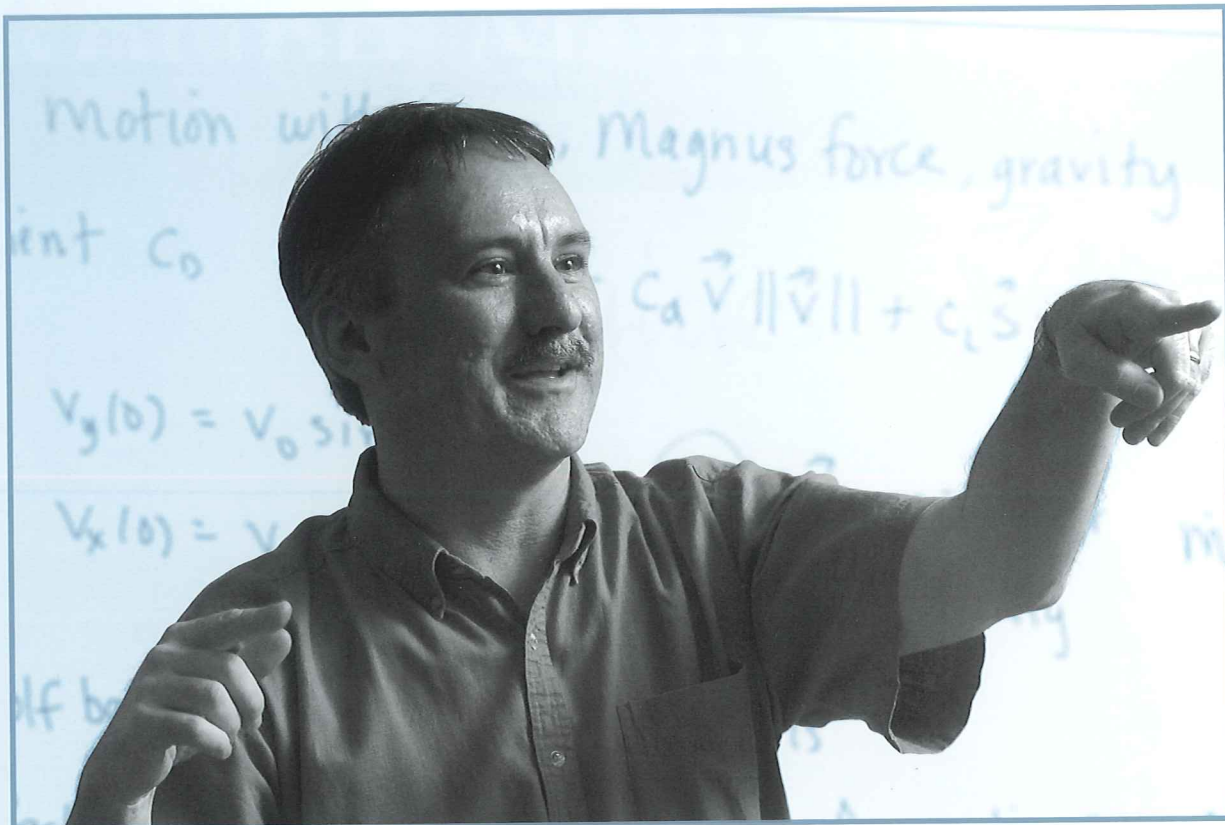o more than visualize the basic play of the sport — somebody throws a ball; somebody tries to hit it. It gives the students visualization and context."

A big sports fan himself, Dr. Minton plays golf when time permits and says he watches sports on TV even if time doesn't permit. He also has developed a simple but effective system for ranking college football teams that has been published by COMPAC, a consortium of college educators and other contributors. "The things you learn in linear algebra at Roanoke College are exactly what's used in this rating system," he says.

His sports statistics have attracted attention, winning him invitations to speak at two recent sports science conferences. His sports applications fall into three main math areas: calculus, differential equations and statistics. "Many of them are ideal applications in that everyone can visualize the physical process, and some basic math gives us insight into various aspects of the sport's strategy and techniques. At the same time, seeing the math in a sports setting often enables students to better understand the motivations and techniques used."

Dr. Minton's other interests include chaos theory and artificial life. He says that although the study of artificial life is interesting and useful, it doesn't fit the standard math course, but he has taught it in an honors course called "Life at the Edge of Chaos" and in a senior symposium.

Chaos theory is a topic that people genuinely get excited about, he says, and he's fond of slipping chaos theory problems into his classes. He also has taught a math senior seminar on the topic. "Along with summarizing the math major, we try to give students a new and interesting topic to look at, so I used chaos because in developing some of those ideas students would have to use a variety of the types of math they've been taught along the way." He has given talks on the subject to everyone from his daughter's third-grade class to the Roanoke faculty. In addition to teaching and producing textbooks, Dr. Minton frequently conducts math workshops for schools and community groups.

Math is certainly a way of life in the Minton home. Dr. Minton's wife, Jan, also teaches math at Roanoke College and is associate director of the College's honors program. Their son Greg got turned onto math by taking part in the Math Counts program. "He started looking at textbooks on algebra and trig and just accelerated to an unbelievable extent," Dr. Minton says, adding that Greg is now one of the top high-school math students in the country. Daughter Kelly is a student at Mary Washington and very involved in music projects and her biology major.

Dr. Minton earned his B.S. in mathematics from Virginia Commonwealth University and his M.S. and Ph.D. in mathematics at Clemson University. He spent four years at Virginia Tech before joining Roanoke College in 1986.

"My work at Tech primarily involved research, and I enjoyed it to some extent, but I was more interested in teaching," he says. "Interviewing

here gave me the idea that a small liberal arts school would be a great place to be for the long term, and it's proved to be so. This is a happy place to work."

"Much to my surprise, the math majors here have been more enjoyable than those I had at Tech," he adds. "There, it was more of the engineering mentality, focused on getting the calculations done. Here, students are much more likely to get really excited about math, and the quality of math majors is as good as or better than Tech."

For its size, Roanoke College turns out more math graduates than one would expect, Dr. Minton says. A lot go on to graduate school; some teach; others become financial consultants or economic analysts. One recent graduate is the personnel manager for a local construction company. Dr. Minton doesn't find that surprising. "He got a degree and skills, the ability to break a large problem into smaller, more manageable parts, to analyze data, to handle long term planning. The abstract mathematics courses he took made him a flexible thinker who can take an ever-changing set of business constraints and identify effective courses of action," he says.

That, incidentally, is the argument Dr. Minton used for television personality Rosie O'Donnell, who was quoted saying that math needn't be taught because we have computers and no longer need to know why 3x=2y/4. In a witty riposte that was published widely as a newspaper opinion piece, Dr. Minton countered by showing that math is useful, enlightening and produces highly prized critical thinking skills.

Dr. Minton puts the same thought into his teaching style, which is part lecture, part discussion. "I've found that most math students really want the help they get in lectures. So I still lecture quite a bit, but I certainly try to make it an active listening and response experience. I throw out questions to the students, and the more they can interact, the better.

"Having been a student who'd rather die than speak up in class, I don't call on people much, but I do

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> — *Dr. Roland Minton*

watch faces a lot," he says. "And if I see someone looking quizzical, I'll stop to see if they have a question."

"I'd like students to be learning the math and enjoying it to the extent that they want to tell others something about it," he says. Using sports examples helps. Dr. Minton recalls one of his senior students who after a lecture in which he used a tennis example said she couldn't "wait to tell this to my boyfriend. He thinks he knows everything about tennis, but he didn't know about this."
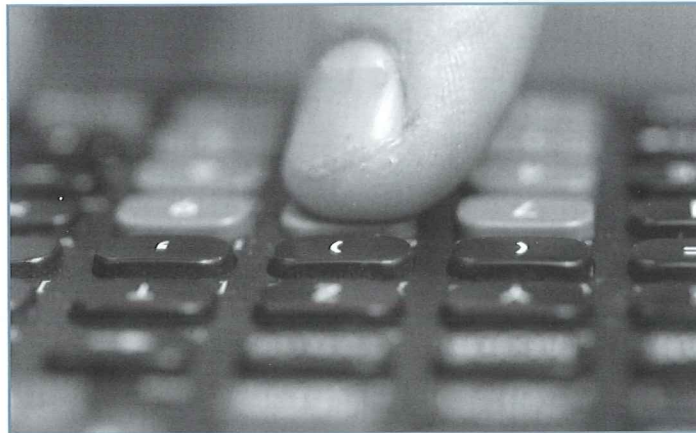
Nevertheless, even calculus students sometimes suffer from the "I'm-not-good-at-math" syndrome, Dr. Minton says. "Typically, it's a self-fulfilling prophecy." He cites recent research on newborns indicating that concepts of numbers and arithmetic are present from birth. "Anyone who has watched young children at play knows that counting and organizing and trading are natural and enjoyable aspects of playing. Humans naturally enjoy mathematics. But if they start to find the going a bit difficult and get no help from teachers or parents, it's easy to lose that enjoyment," he says.

Now that his book is affecting calculus education at the international level, Dr. Minton is considering how he might improve it on the local level. One thought is to offer more of the math workshops he conducts at middle and high schools. Another is a pet project, not yet realized, to sponsor a math camp for middle school students.

One thing is certain – Dr. Minton has more than enough enthusiasm to make any project a success. "I want students to appreciate math, to be excited about it. I want them to realize that math is way more than solving equations and getting x equals y. It's a way of thinking and analyzing information on a wide diversity of topics," he says. "Every time you sit down and analyze the properties or the patterns of anything, you're doing math. It shapes how you think. And those critical-thinking skills are the keys to a life that's rewarding, both financially and psychologically."