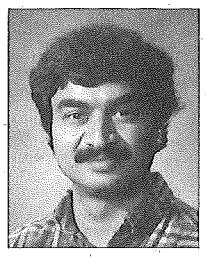


Anil Shende ...

"Programming" students to think boldly, explore new ideas, test assumptions

by Joan Bugbee

"Computer science is the study of a model of computing we currently have. We can program it, but there are limitations to this model, things we cannot compute, a host of things we don't know. As computer scientists, my students must be able to analyze this model, know its limitations, and ask questions: Is this the right model? Could we do it better, faster, another way?"

Students may sign up for Anil Shende's computer classes expecting to learn programming, and they will; but Dr. Shende has something much more exciting in mind: he wants to teach them to think.

And not just to think, but to think boldly, ranging far afield, exploring new ideas, analyzing problems, testing assumptions. That is the very stuff of computer science in the view of this Roanoke College assistant professor of computer science. His goal is not merely to give students technological tools, but to give them the ability to think critically about their use, to analyze the "why" as well as the "what" of computing. To get students thinking in those terms, he challenges them with unconventional ideas.

"A computer is a mathematical model based on numbers," he tells them. "But there's nothing sacred about this model — perhaps there is another model that may be better.

"Maybe we're doing things the wrong way; maybe everything is not based on numbers. Could we go another way? Instead of numbers, could we base a computing model on, say, music, which appeals to our emotions? Would such a model behave more like a human? Could we use such a model to also compute with numbers?

"We don't know which way is the right way, but to explore other ways, we first need to know what's right and wrong about the present way."

Exploring such questions takes mathematical aptitude and logical thinking, Dr. Shende points out. It involves the theory of computer science, its essence, as opposed to programming, which is just one aspect of it.

In terms of programming, Dr. Shende notes that many students don't realize how much work programming involves. "I tell them that learning programming is like learning how to ride a bike; you have to get on a bike and fall off a few times and only then do you actually learn it. They learn programming by doing it. I guide them but leave things open-ended; I give them a problem and encourage them to come up with a design to solve it. I'll help, but I would rather have them see the errors themselves and get a little frustrated, because even seeing the errors is a learning experience."

He believes that technology effectively enhances the learning process. "Information on the Web can be made available to students without their having to do a search," he points out. "Instructors can set up Web pages for their courses using information from the Web and including links to other relevant information."

All material for his own courses, including the syllabi, links for labs, labs themselves, tutorials, and so on, is on-line, accessed by students with their user names and passwords. The process is interactive; students can pull up a test on their computer screen, answer questions, and send the test electronically to Dr. Shende who grades it, makes comments, and sends it back electronically.

Personal interaction, in class and in the instructor's office, is still necessary and valuable, Dr. Shende emphasizes. "But using the computer eliminates a lot of paperwork. For computer science students, it is important that everything is on-line so they can see how it is actually done." Because the job market is "drenched in technology," as he puts it, all students, regardless of their field, need computer skills, from word processing to using spreadsheets and accessing the Internet and World Wide Web.

A native of India, Dr. Shende completed his undergraduate work in computer science at the Birla Institute of Technology and Science in Pilani. He came to the U.S. for postgraduate studies at the State University of New York at Buffalo, where he earned both his M.S. and his Ph.D. in computer science. His wife Susheela, whom he met at college in

India, holds a master's in urban planning from that university.

Prior to coming to Roanoke College in 1995, Dr. Shende taught computer science at several institutions, including SUNY-Buffalo, Haverford College, Dickinson College in Carlisle, PA, and Bucknell University.

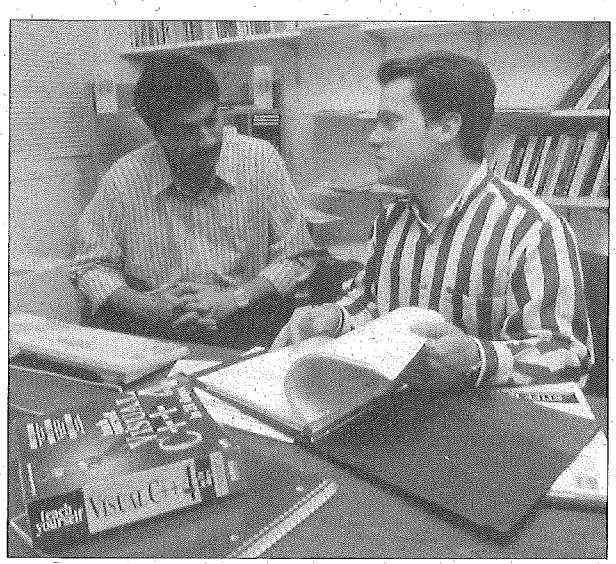
Size, reputation, and location drew him to Roanoke College. "I've always liked smaller environments, as opposed to large universities where you don't really have a chance to get to know the students," he says. "I love the size of Roanoke and the name the school has. Of the different small colleges I've seen, Roanoke College is probably the best as far as technology goes. It has really moved ahead very quickly, keeping pace with all that's going on in computer science.

"The job market is drenched in technology ... Students need computer skills, regardless of their field."

His course load currently includes "Introduction to Computer Science," "Database Systems," "Computer Organization," "Operating Systems," "Analysis of Algorithms," and "C++ Programming and UNIX."

For independent study, he also teaches "Parallel Algorithms," his specialty and exactly the sort of complex subject that develops analytical skills. It is allied to his research this past summer, funded by a Roanoke College research grant, on hypercubes — mathematical structures which are arbitrary dimensional cubes (arbitrary in the sense that they have no limit).

"The problem, first posed in 1958, was, given an n-dimensional cube, what is the length of a longest 'snake' "? Dr. Shende says. He explains that a snake is a path in a hypercube in which no two non-adjacent vertices in the path are adjacent in the hypercube.



Anil Shende works with Rick Pingry, a Roanoke College Summer Student Scholar who is exploring computer-generated, three-dimensional (3D) animation.

"I had some hunches about what might lead to a solution in some dimensions — I already hold the record for finding the longest snake in dimension 8. But you have to generate all possible snakes in all dimensions. There are two ways to do it: empirically and analytically. I'm trying to do both: to generate patterns and then try to prove patterns."

But since there was no hope of testing all possibilities with a conventional computer, he decided to distribute the task among all 130 lab computers at night, when most are idle. "This is distributed, or parallel processing, in which you start the program on one computer and the program distributes itself across the others."

One of his key contributions to the College was introducing the Linux operating system, a form of UNIX that runs on personal computers. "This is beneficial for two reasons," he explains. "First, UNIX is the platform graduate students use, so it's important that our students be familiar with it. And second, we were able to put Linux on all our computers in the labs very inexpensively, which is important to small colleges with restricted budgets."

Recently Dr. Shende was awarded a grant from Microsoft Corporation, in the form of licenses for a software product that can be used for teaching programming and for enhancing Web pages. He is the recipient of several research grants awarded by Roanoke College as well as a Mellon research grant and a National Science Foundation grant for research into assertion-based programming.

Additionally, Dr. Shende has served as a "referee," an expert who reviews articles for publication, for *Theoretical Computer Science* and for the 1997 Annual International Symposium on Algorithms and Computation and the 1997 Annual Southeastern Small College Computing Conference. He has published technical papers in such prestigious journals as the *Journal of Experimental and Theoretical Artificial Intelligence*, *International Journal of Algebra and Computation*, *Discrete Mathematics*, *Journal of Computing and Informa-*

tion, and *Annals of Mathematics and Artificial Intelligence*.

He is a member of the Association for Computing Machinery, the Consortium for Comput-ing in Small Colleges, and the Virginia Academy of Science; he serves on the steering committee for the 1997 Annual Southeastern Small College Computing Conference.

His campus activities include providing technical assistance for the College's Web page and directing an on-campus computer camp for high school students during the summer. The camp focused on creating interactive Web pages using the Java programming language. "This gave students their first exposure to creating their own Web pages independently, which required a lot of logical thought. They learned it wasn't just fun and games," Dr. Shende says.

He also has developed a computer program that will enable all instructors to plan their courses online. "The program creates a directory structure. The teacher will specify the type of questions which will be put on an electronic form; students will answer questions on their computers and e-mail the form back. Instructors will then grade the questions and e-mail the results to the student.

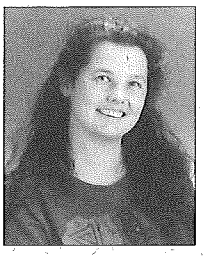
"Different instructors have different needs," Dr. Shende points out, "but once they see what the program can do, they will be able to help with input into what sorts of programs can be most effective for them." He adds that much of the work was done by students under his guidance. "A big university would have a group in information services doing this sort of work, but very rarely would there be interaction with any faculty member on the design aspects. Roanoke College students got invaluable first-hand experience on this project. It's the sort of thing that can happen only in a small college."

And only in *this* small college, perhaps, are students exposed to the theory of computer science in ways that tease their minds with fresh, provocative ideas. Dr. Shende says, "We know several problems that computers can't solve, but we don't know that about humans. Normally, I get my students to think about that by asking them if humans are mechanistic devices. When they say no, I ask why. They usually don't have an answer. So I ask them, given a scenario, does your reaction to that scenario involve all your past experiences? Their answer, generally, is yes.

"Then I ask if experiences are finite, and they answer yes. Finite experiences can be mathematically encoded. So if your reaction to a scenario is based on all your past experiences, and here's a number for the scenario and here's another number for all your experiences, then your reaction is simply a function that takes these two numbers as input and gives me this output. In other words, it's a deterministic process. If that is the case, a human could very well be a mechanistic device.

"If we could find one thing computers can't do that humans can do, then we would know that human beings aren't mechanistic devices."

He sums up: "To do that analysis, to even begin thinking about these things, you have to be able to first analyze the model of the computer. That is why reasoning about it is important. To me, that is the real crux of computer science."



Elizabeth Heil ...

Exploiting Technology as a Constant Source of Potential Growth

by Mark Morrison and Kevin Kittridge
Staff Writers for *The Roanoke Times*
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(Roanoke College editor's supplements appear in italics.)

If she wasn't an artist, Elizabeth Heil says she probably would fix cars or build houses for a living.

She always has been fascinated by building and construction. In fact, she says it's a cornerstone of her work as an artist.

Heil, who is an associate professor of art at Roanoke College, uses computers to combine photographs, drawings, and other images into a series of original layered collages.

But her fascination with building doesn't stop there. It's also a cornerstone of her own identity, she says, traceable to her immigration from post-war Germany with her family when she was one year old.

At the time, Germany was undergoing a painful reconstruction period in the years after World War