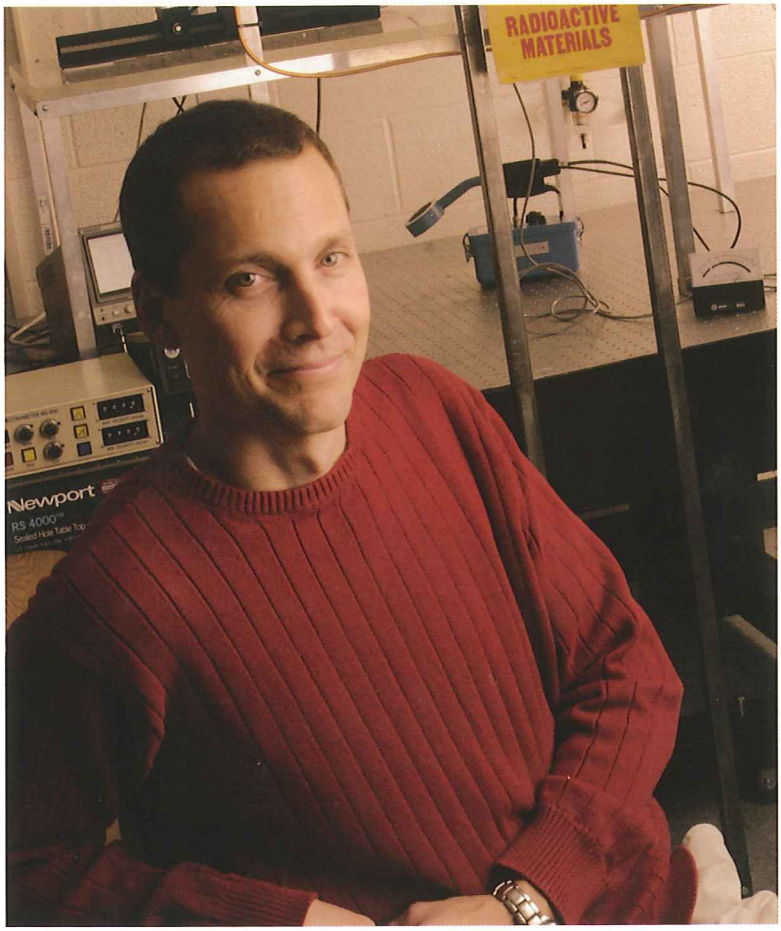
From nanoscience to science education

Richard Grant's scientific approach helps students from kindergarten to college

Dr. Richard Grant initially planned to spend his sabbatical studying iron-filled carbon nanotubes with colleagues at Wake Forest University. However, other projects he had been working on fell into place, forcing a change of plans. He ended up spending the semester working on three distinct projects. "As it turns out, these projects illustrate the different areas of scholarship I'm involved in," Grant explains. "As a scientist, I feel I can help improve science education at the K-12 level and the college level as well as contribute to the scientific community through more traditional research."



Grant's turn-on-a-dime flexibility explains, in part, why this Dean's Council Exemplary Teaching Award winner is so successful in the classroom. "I love teaching, and I get especially excited when a student gets it and says, 'This is pretty interesting!' When that 'Aha!' moment happens, it's a good thing," says Grant, who joined Roanoke in 1996 and has been recognized twice with the college's Faculty Scholar Award.

The associate professor grew up in Burlington, Ontario, Canada. After earning a B.S. in physics from the University of Toronto and an M.S. in physics from Florida Institute of Technology, he went to Old Dominion University to complete both an M.S. in applied physics and a Ph.D. in physics. He specializes in materials physics, especially nanophysics and corrosion processes, but he also loves developing pedagogical tools for teaching science, particularly at the K-12 levels.

Science for teachers

That love led Grant into his first sabbatical project, which revolved around his long-standing interest in improving the teaching of mathematics and science. "The nation has fallen behind in math and science," he says. "Science education at the elementary level, especially, is not where it needs to be. I'm just trying to do my little part in improving the situation."

For the last 10 years, Grant has conducted workshops in teaching science in the schools, mainly at the elementary level. His sabbatical gave him time to develop science kits for K-12 teachers in Virginia. His project, funded by the State Council of Higher Education for Virginia, was part of a multi-institutional collaboration with the University of Virginia and Hampden-Sydney College and focused on

improving science education. Physics major David Cook assisted Grant in completing the project and received independent study credit for his efforts.

Science for students

"You have to be a good listener to be a good teacher," Grant adds, "but you can't just say, 'No, here's the right answer.' You have to analyze *why* the student asked the question, *why* there was a misunderstanding. Basically, you have to know *how* their brains work."

With those principles in mind, Grant spent the largest portion of his sabbatical on a project funded by Brooks/Cole Publishing Company, authoring material to be included in online homework and tutorial programs. For the fourth edition of *Principles of Physics*, a widely used college textbook, he authored problems that incorporate hints and smart feedback based on the latest findings from physics education research.

"It's an incredibly detailed program," Grant says. "The faculty will get direct feedback that will be very helpful to their teaching, and students will receive hints and smart feedback when they give the wrong answer to a problem." Roanoke students will benefit as well when Grant uses the program in his Physics 201, 202 and 203 courses.

"As a scientist, I feel I can help improve science education at the K-12 level and the college level as well as contribute to the scientific community through more traditional research."

— Dr. Richard Grant

Science for scientists

As a final project, Grant began collaborating with his advisor, Dr. Desmond Cook from Old Dominion University, on a project focused on understanding marine-exposed corrosion processes. Applications of this work include restoration efforts on historically significant marine artifacts such as the USS Monitor.

To assist him with work on the project after the sabbatical, Grant enlisted over the summer the help of two physics majors, Laura Cassels and Mathew Miller. "I helped get them started with the project and let them run with it, and they did," he says. The restoration and preservation of marine-exposed materials is a challenge to conservators and scientists. The goal is to restore artifacts that have undergone severe deterioration due to prolonged exposure to water, soil and pollutants and to prevent their further deterioration. Unfortunately, little is known about the actual process of corrosion, so it's difficult to achieve this goal.

"Rust is not simply rust," Grant explains. "There are many different iron-oxides that can be present in a rust sample in varying amounts and particle sizes. The work over the summer focused on studying one particular iron-oxide, Akaganeite, formed as nano-sized particles." One nanometer is one billionth of a meter or about 1/100,000th the width of a human hair. Grant and his students use a technique called Mössbauer spectroscopy and a closed-cycle refrigerator to study samples at temperatures down to 15 K, or about - 432° F.

"Mössbauer spectroscopy provides a 'fingerprint' of the oxides present in a sample, and at temperatures that low we're able to separately identify not only the oxides but variations in the particle size of those oxides," he says. By identifying the different oxides and their particle sizes formed in marine-exposed rust, Grant hopes to gain some insight into the corrosion process.

For a separate but related project, Grant, his Roanoke physics colleague Dr. Rama Balasubramanian and researchers from the University of Maryland have submitted a proposal to the National Science Foundation requesting funding to undertake a collaborative study to understand the fundamental growth mechanism of carbon nanotubes.

Roanoke as a Testing Ground

"It is a difficult task to write a large proposal to outside funding sources," Grant says. "Starter grants and other internal funding sources provide the opportunity to purchase equipment and supplies as well as enlist student assistance. In effect, Roanoke provides the seed money for what will hopefully become much larger projects."

Although Roanoke strongly supports faculty research projects, Grant says the College remains first and foremost a teaching institution. "We don't have the publish-or-perish pressure, where you have to crank out publications every year. However, we're expected to remain active scholars and at the same time, we're encouraged to use students in our research. It's a system that works." ◆