Margot Vigeant

of Bucknell University

Theresa Gawlas Medoff

There are some things that we ought to know—like that in a 70° F house, the floors are all the same temperature, regardless of whether they are carpeted or tiled—but somehow, we don't fully grasp the concept. Ask your average person, even an engineering student, and he or she will likely say that the tile floor is colder. That same engineering student could solve a math problem related to temperature, but that's not the same as fully understanding the concept. And when engineers make mistakes on fundamental concepts, it could lead to major problems.

Margot Vigeant in class, talking to a first-year student.

"It's really not good for a chemical engineer to be running around the plant thinking that different areas are somehow different temperatures just because the materials they are made of are better or worse heat conductors. We need to teach our students to translate their theoretical knowledge into conceptual knowledge," points out Margot Vigeant, whose current research focuses on assessing the prevalence and persistence of engineering students' misconceptions—and most importantly, finding ways to correct those misconceptions so that the lessons stick. She and Bucknell collaborators Mike Prince, professor of chemical engineering, and Katharyn Nottis, professor of education, have presented and published on this work, and they are working toward writing a packet of inquiry-based problems that could be used as a part of a chemical engineering workbook.

An associate professor of chemical engineering and associate dean of the College of Engineering at Bucknell University, Vigeant has spent much of her faculty career focusing on improving engineering education. Not only has she applied new teaching methods to her own courses, but she also has worked within the college and with colleagues at other colleges and has participated extensively in the American Society for Engineering Education (ASEE).

"Margot is well respected in the chemical engineering education community," says James Patrick Abulencia, assistant professor of chemical engineering at Manhattan College, who is

Clad in plaid: Second-grader Margot smiles for the school camera.

currently working with Vigeant on a National Science Foundation-funded project to use video to enhance conceptual learning in thermodynamics courses.

Vigeant siblings Mark, Margot, Peter, Benjamin, and Fred at Peter's wedding. Can you guess which one is pursuing a sideline as a standup comic?

CREATIVE INFLUENCES

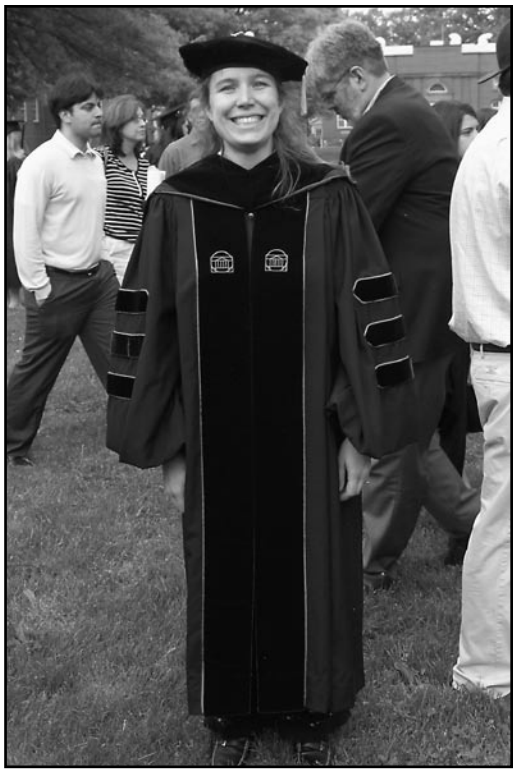
Perhaps Vigeant was destined to be an engineer—well, either that or an actress. She grew up in Stratford, Conn., the oldest of five children. The others were all boys. Theirs was a household in which engineering and other pursuits more traditionally thought of as creative were equally encouraged. Their father, Fred Vigeant, a chemical engineer by training, worked in marketing communications for Ciba-Geigy, which in 1996 became Ciba Specialty Chemicals. Their mother, Anita, was a caterer while the children were growing up, then went back to school and works as a nurse manager with the Visiting Nurse Association. "She is very hard working, and was always supportive of her children no matter what we were interested in, whether creative or technical," Vigeant says.

As she notes, the performance art line and the engineering line run through them all to greater or lesser extents. Vigeant has a great affinity for theater and literature, and she had considered being an English major in college. Even after she decided to pursue engineering as a discipline she remained involved in theater, performing in two Shakespearean plays while in college. The oldest of her four brothers works as the program director for an NPR station; another (who studied interactive technology at NYU) is an interaction and game designer; the third brother is breaking into improv theater in Chicago; and her youngest brother, Mark, just graduated from college with a degree in information science and is pursuing a career in that area as well as in banjo-unicycle-standup comedy.

Vigeant and several family members play musical instruments, and have been known to play together at nursing homes and other organizations during the holidays under the name the Vigeant Family Brass. She dons her orange-and-blue rugby shirt and her personalized orange-and-blue Chuck Taylor Converse All-Stars—a gift from her husband—to play the trumpet in the Pep Band at Bucknell basketball games.

As a child she would sometimes accompany her father to work, which she says was instrumental in pointing her in the direction of chemical engineering. "Chemical engineering is not something you can pretend to be as a child," she points out. "You can use Legos to play 'civil engineer' or kitchen ingredients to play 'chemist,' but there's no way you can play 'chemical engineer.' Half of the people in my undergrad ChemE class had a parent who was a chemical engineer. Otherwise they wouldn't have known about it as a career."

When Vigeant was a high school junior and senior, her father arranged for her to shadow several fellow employees at Ciba-Geigy to give her some career direction. "It seemed to me that chemists worked in the lab all the time," she says. "The chemical engineers got to move around to offices and different plants and work with a variety of people. The one female chemical engineer I shadowed took me to lunch in her beautiful red Corvette. It seems shallow now, of course, but that helped to sway me. It seemed like chemical engineers enjoyed a better life!" Vigeant—who drives a minivan, not a Corvette—still thinks she made the right career choice.



Grinning graduate Margot poses in her official University of Virginia regalia.

FROM CORNELL TO UVA

Once she decided to pursue chemical engineering, it was a fairly easy choice to matriculate at engineering powerhouse Cornell University. She enjoyed her undergraduate experience there, particularly the extent to which she was able to take courses outside her major, an opportunity that was facilitated by the AP credits she had as well as by her willingness to work ahead with summer coursework to free up time and credits. "I received a really solid, rigorous chemical engineering education at Cornell, but I also took courses in French literature, psychology, acting, and as much biology as I could fit in." She was a teaching assistant in biochemistry as well.

As would be expected of Cornell College of Engineering, her chemical engineering curriculum was extremely challenging. "At least in our minds, my chemical engineering classmates and I were in the most difficult major in the most difficult college in this extremely difficult university, and we liked it that way," she recalls. "We didn't sleep much, and the extent to which we collaborated was based on the curve. There was definite competition among us."

Margot among proud members of the Bucknell Pep Band playing at the Patriot League Basketball Championships, 2011.

Vigeant says she was particularly influenced by Dr. Michael Shuler, the James and Marsha McCormick Chair of the Department of Biomedical Engineering as well as the Samuel Eckert Professor of Chemical Engineering in the School of Chemical and Biomolecular Engineering at Cornell University. "When he talked about his research work in our Introduction to Chemical Engineering class, it was very inspiring," she says. At the time, back in 1990 or so, Shuler's research group was working on the drug Taxol (used to prevent reoccurrence of breast cancer) and the challenges of synthesizing and processing it. "One of the things you want to answer for yourself while an undergraduate is, what can I do with a chemical engineering degree, and seeing his research helped me to answer that," she says.

One of Shuler's graduate students, Susan Roberts, now director of the UMass Institute for Cellular Engineering, was also a big influence on Vigeant. "She helped me think through graduate school applications, and then was a critical resource again when I was applying for faculty positions. She's been an important professional mentor for me," Vigeant says.

When she was applying to graduate programs in chemical engineering, she had every intention of entering the pharmaceutical industry, which is one of the reasons she ended up at the School of Engineering and Applied Science at the University of Virginia. She was looking for a graduate school where she could delve into the biological aspects of chemical engineering, which is one of the major thrusts at the University of Virginia. Margot ended up working closely with Roseanne Ford, Cavaliers' Distinguished Teaching Professor and chair of the department of chemical engineering at UVA, who was indeed working on the biological aspects of chemical engineering, but from an environmental perspective, *not* pharmaceutical.

EARLY EXPERIENCE AS A RESEARCHER AND TEACHER

"Ford's project was just so compelling that I really wanted to work on it," Vigeant says. Ford and her team of graduate students and post-doctoral fellows (comprising chemical, mechanical, environmental, and civil engineers)

in the Program for Interdisciplinary Research in Contaminant Hydrogeology (PIRCH) were researching the possibility of using contaminant-consuming bacteria to clean ground water polluted with gasoline components such as methyl tertiary butyl ether (MTBE) and trichlorethylene. The problem was getting the bacteria to go where the researchers wanted and to selectively seek and destroy the contaminants. Vigeant's research focused on individual bacterium and how bacteria move through the water's surface.

Research director Ford says, "Margot's project advanced my research program into important new directions. Bacterial adhesion to surfaces is not well understood, particularly with respect to the initial attachment events. What little was understood had been inferred from macroscopic-scale experiments. Margot studied the behavior at a microscopic level to gain some insight into the mechanisms governing bacterial adhesion. The other interesting aspect to her project was that the bacteria were motile—actively swimming—so the techniques used to study the initial attachment events had to be noninvasive."

Ford says that of all her graduate students, Vigeant stands out for her creativity and being able to bring a unique perspective to the problems the research group was working on. "One thing about working with Margot is that it broadened my research program because she asked questions and suggested approaches that I would not have thought about. There was one measurement we had been trying to make for a long time, and we couldn't figure out an exact approach. Margot was at a conference and heard someone talking about something similar. She saw how their approach could be adapted for our use. She is particularly good at seeing connections between fields and she is willing to cross disciplinary boundaries," Ford adds. Margot ended up collaborating with a professor and a post-doctoral researcher at the University of Virginia School of Medicine and using their lab's laser, microscope, image analysis software, and a technique called total internal reflection aqueous fluorescence. In the medical school researchers use the technique to look at cell membranes in great detail; she used it to see how close to the surface the bacteria were swimming.

"Margot was one of the top students I've had in terms of all-around intellectual ability, her work in the lab, her teaching, and her outreach to the community. She was the complete package," Ford says. While in graduate school Vigeant was a teaching assistant in chemical engineering. Ford says that as a teacher, too, she demonstrated creativity. Ford recalls observing a few of the recitations that Margot led for the undergraduate Momentum and Heat Transfer course. "She sang a song [composed by Dr. Peter Harriott] about the Reynolds number to help the students remember how to distinguish between laminar and turbulent flow. She prepared a game of *Jeopardy* to help the students review and summarize major concepts from the course material. The questions were very clever and fun, but also accomplished the goal of testing the students' knowledge of basic concepts. Margot has a knack for explaining difficult concepts in very simple terms. This was one quality that the students really appreciated about her and commented on in the student evaluations."

Vigeant also volunteered regularly as a guest teacher of science at local Catholic schools with her graduate classmate Jenny McNay. They had amazing success in making high-level concepts understandable by even the youngest children. That experience continues to feed into her social outreach to this day, as she has personally presented to Girl Scout and Boy Scout troops and has involved her students in working with youth groups and science teachers as well.

VIGEANT'S AWARDS
Professional
Best Paper Educational Research and Methods division, Best Paper Program Interest Group IV, ASEE (2011)
Hutchison Medal award from The Institution of Chemical Engineers, with Michael Prince and Katharyn Nottis (2010)
ASEE National Chemical Engineering Division Ray W. Fahien Award for teaching effectiveness and educational scholarship (2009)
Bucknell Presidential Award for Teaching Excellence (2006-07)
Nominee, AAUW Emerging Scholar Award (2004)
Nominee, best division paper ASEE Freshman Programs Division (2003)
Graduate
Chemical Engineering Faculty Award for Excellence in Doctoral Study (1999)
AAUW Selected Professions Dissertation Fellowship (1998-99)
UVA SEAS Graduate Teaching Assistant Award (1997)
Dean's Fellow (1994-1997)
Undergraduate
Tau Beta Pi National Engineering Honor Society

LANDING THAT DREAM JOB

With doctorate almost in hand, it was time for Vigeant to begin the job search. She looked broadly, including the pharmaceutical industry, various colleges and universities, even the CIA. Then the offer came for her dream job: as a tenure-track assistant professor at Bucknell University. "I remember a friend of mine who had graduated the year before telling me that on university job interviews you should talk only about research, never about wanting to teach students," she recalls. "But it was important for me to be able to go on an interview and say, 'I am interested in teaching undergraduate students.' I wanted to be at a place where the teaching of undergraduates is valued, not just an obliga-

tion. Bucknell is one of a very few liberal arts, undergraduate-focused, educationally focused schools with a chemical engineering major."

Margot, husband Steve, and sons Gabriel and Simon at Star Wars Celebration V, on the Millennium Falcon.

She began teaching at Bucknell in the fall of 1999. Early on in her career, Vigeant gave an talk titled "Teaching at a Four-Year College: Why Would Anyone Do This?" to her former colleagues in the PIRCH Seminar Series at the University of Virginia. She espouses the same feelings today about teaching that she expressed then: "It's all about changing the world. I really think that engineers have an opportunity to make the world a better place. Consider the story of penicillin. It was chemical engineers who found a way to deliver on the drug's promise by finding a way to mass produce penicillin and make it easily accessible. I could have helped to educate lots of other people and send them out there to change the world. You can multiply your effectiveness that way." After just 12 years of teaching Bucknell undergraduates, she figures that she has helped to train some 300 chemical engineers.

While that's the overarching motivation for teaching undergraduates, she points to many other rewards as well. "It's fun to try and get people excited about something you're excited about," she says, "and I derive great satisfaction from watching light bulbs turn on. Teaching is also a great way to learn. Students ask me something that causes me to figure out a problem I hadn't considered before, and when I'm teaching a new course I get to do lots of reading in new areas."

A FAMILY OF HER OWN

Vigeant was lucky enough to find the love of her life early on—very early on. She married her high school sweetheart, Steve Stumbris, in 1996 while still in graduate school. Stumbris also earned a bachelor's from Cornell, where he majored in mechanical engineering. He, too, is a theater lover who performed in student-led plays at Cornell. Both enjoy attending performances at Bucknell, which is known for its theater and dance programs. His career took a different direction from hers, and he worked as an engineer in various industry settings until a few years ago, when he joined the Bucknell University Small Business Development Center, where he is in charge of Engineering Development Services. Bucknell's SBDC is the only one Stumbris knows of that helps clients with product development, often with the assistance of the research of engineering students. "It was a wonderful alignment of our careers for us both to be at Bucknell," he says.

The couple has two sons, Gabriel, 10, and Simon, 7. As would be expected, their lives are busy with work, family, and children's activities such as scouting, soccer, and indoor rock-climbing (an activity to which Gabriel, particularly, has taken a liking). They wake at six every weekday morning, get the boys on the school bus by seven, and are in their offices before eight. Then it's full steam ahead until bedtime.

Weekends are devoted to family as much as possible, but even on their very busy weekdays Margot always finds the time to stop and listen and teach the children. Says Stumbris: "We often read ingredient lists with the kids. Just this morning over oatmeal Simon was reading the ingredients in his gummy vitamins and he was amused to see that they contained metal. That comment got Margot going on a 10-minute discussion about the function of iron in transporting oxygen in the bloodstream—and we still made it to their bus on time.

"Margot is always curious and enthusiastic. She might read or hear about a topic with the boys and they'll go off and research together to learn more about it."

Students and faculty from Engineering in the Global and Societal Context 2010: Brazil on top of Sugar Loaf, overlooking Rio de Janeiro (Margot, far right).

BRINGING A CREATIVE FLAIR TO ENGINEERING EDUCATION

Vigeant brings that same intellectual curiosity to the classroom, which inspires a similar attitude in her students. Recognizing that thermodynamics is an intensely challenging mathematical subject, she livens up her "quests" (something that falls between a quiz and a test) by using them to tell a story throughout the semester. She has used the story of Tristan and Isolde, and the Greek myth about the quest for the Golden Fleece, which has the added benefit of actually having mechanical monsters already built into the story. Last year's senior chemical engineering class playfully presented her with a golden-edged certificate for being "Most Likely to Slay a Dragon Using the Rankine Cycle."

"Dr. Vigeant was one of the most charismatic, energetic professors that I had. She was always in a great mood and tried to make any subject interesting, even thermodynamics," says David Van Wagener, '06, who went on to earn a doctorate in chemical engineering from The University of Texas at Austin. He now works as an associate engineer in the field of Sustainability Technologies at ConocoPhillips in Bartlesville, Okla.

She incorporates problem-based learning into her courses whenever possible. She rarely lectures to her Applied Food Science and Engineering students, for example. Instead, throughout the semester she presents them with a series of challenges, such as, "Is it possible to make a good doughnut that can be advertised as 'baked, not fried'?" The students start by frying doughnuts in class to see what sort of taste and consistency to aim for, and then begin innovating recipes and alternative cooking methods like steaming, baking, and cooking the dough in a panini-type press. While all that is going on, she passes around bags of baked and kettle-cooked "potato chips" for the students to taste and compare. They, too, are encouraged to look at the ingredients, where they learn that the baked chips are made to a significant extent of corn, not potatoes.

She uses that same investigative approach in the Bucknell engineering course designed for upper-class arts and sciences majors. When the innovator of that course retired, Vigeant had the opportunity to re-imagine its contents and methods. She changed the name, from "Technical and Critical Analysis" to "Life, the Universe, and Engineering." When she teaches the course, she works with students at the start of the class to set the agenda for which technologies (*e.g.*, cell phones, mp3 players, massive skyscrapers) and systems (*e.g.*, the Internet, genetic engineering, air pollution regulation) the class will study that semester. When possible, they actively answer the question "How Does It Work?" They might collect old cell phones, for example, and then smash them open to see the inner workings. They also discuss the social implications of the technologies or systems. The course is very popular at Bucknell, unfailingly enrolling to its target capacity of 16 students.

REVAMPING ENGINEERING AT BUCKNELL

Before Vigeant joined the faculty at Bucknell, there already was a concerted effort in place to revamp the curriculum to make it more student-centered and give students real-life challenges to solve instead of textbook-based problems. Soon after she arrived, she was enlisted to join fellow engineering faculty members on Project Catalyst, an NSF-funded, internal effort to "Engineer Engineering Education" at Bucknell. From that effort sprang the complete overhaul of both the first and the final courses that all Bucknell engineering students are required to take: Exploring Engineering and Senior Design.

Although not mandatory, many faculty redesigned their other courses as well. "We got the College of Engineering talking about ideas, reading books, listening to speakers, and developing new strategies for how to implement new methods of teaching," she says.

"Margot took a number of leadership roles in advancing the curriculum both within the Department of Chemical Engineering and in the College of Engineering as a whole," notes Jeff Csernica, professor of chemical engineering and chair of the Department of Chemical Engineering at Bucknell. He praises her "tireless work" on the various committees and subcommittees charged with broadening and improving the engineering curriculum. "She serves as a role model, not only to our women engineering students, but also to other faculty in terms of the vitality, creativity, and professionalism that she brings to her work," he adds.

Vigeant is quick to point out that colleagues have been instrumental in getting her into the practice and scholarship of teaching engineering. In particular, she points to Bucknell chemical engineering colleagues Mike Prince, Mike Hanyak, and Bill Snyder.

Taking one for the team: Margot getting hit by a water balloon during the first-year "Douse the Deans" water balloon catapult-building event.

Bucknell is working to make engineering education more global, and Vigeant has been an ardent supporter as well. In June 2010 she and colleagues Felipe Perrone, professor of computer science, and Tim Raymond, professor of chemical engineering, accompanied a group of 25 students from various engineering disciplines to Brazil for an intensive, three-week course, Engineering in the Global and Societal Context, that looks at engineering (education, businesses, projects) in another country within the context of that nation's culture and history. In June 2012 she will be going to China with another group of Bucknell engineering students and colleagues Xiannong Meng, professor of computer science, Jie Lin, professor of electrical engineering, and Keith Buffinton, dean of engineering.

EDUCATING FROM FIRST YEAR TO SENIOR YEAR

Recognizing that it is important to grab the attention of students early to keep them interested and engaged in engineering, Vigeant took on a leadership role in the redesign of the first-year seminar Exploring Engineering. She also served as coordinator of the course for three years. The course begins with a brief introduction to different types of engineering majors at Bucknell: biomedical, chemical, civil and environmental, computer science, electrical, and mechanical engineering. Then, students select three, three-week engineering challenges to complete with their classmates. One that she devised, which is still among the offerings, was "Engineering Athletics," a challenge to engineer a "better" (as defined by the students themselves) sneaker sole.

Vigeant's biggest contribution to the Exploring Engineering course was the final challenge of the semester, required of all 200-plus students enrolled in the course's multiple seminar groups. She wanted to make the project not only an engineering endeavor but also a College of Engineering-wide community service project. "Margot is one of the most energetic, passionate, and dedicated people I know," says Karen Marosi, associate dean of engineering at Bucknell University. "She's also incredibly creative, and when she gets a good idea, she'll go after it no matter what the barriers. Somehow she always finds a way."

The course's culminating challenge has changed over the years to keep it interesting and relevant. At first, students were asked to inventory the Bucknell campus and engineer solutions to make it more accessible to people with disabilities. When that subject became exhausted after several years, they did the same for businesses in the college's town of Lewisburg. Since 2006, the students, in groups of four, have been challenged to design and execute a "gizmo" that can be used to teach children a science or engineering concept such as the conservation of energy. Their real-life customers are local teachers and students, home-schooling families, and youth groups like the Boy Scout and Girls Scouts who attend the College's much-anticipated Gizmo Expo each December.

"There's a lot of learning that goes on when students have to convert a paper plan to implementation," Vigeant says. "They have to define what problem they are trying to solve, pick

Last year's senior ChE class playfully presented her with a golden-edged certificate for being "Most Likely to Slay a Dragon Using the Rankine Cycle."

the best solution, defend their choice, respond to customer feedback, build the gizmo—and make it work!" The initial, consulting customers for the gizmos are education students in Bucknell's Teaching Elementary Science course, taught by Lori Smolleck, associate professor of education.

The final step for the student groups is demonstrating the products at the Gizmo Expo. If any of the adults at the Expo request the gizmo, the students have to give it away. "It's our community service," she explains. "I wanted to find a way to motivate the students' projects, to show that there is someone out there who cares about this besides us and for reasons other than a grade."

Vigeant has presented and published numerous times on the first-year course at Bucknell, and particularly the gizmo project that she designed.

The final engineering course that Bucknell students take, Senior Design, got the same kind of overhaul in a project lead by Jim Maneval, professor of chemical engineering. Rather than the final product being a design on paper, the course now culminates with an actual deliverable to a real client, either on- or off-campus. Margot's chemical engineering students frequently work with businesses that come to Bucknell's SBDC. Last year, for example, one group worked with the owner of a natural soap company, Pompeii Street Soap Co., to create an all-natural, detergent-free, liquid hand soap. It was not easy. Turns out, natural ingredients will foam fairly easily, but the customer/company owner did not want a foaming soap. The students did eventually succeed; top-secret formulation and product development is ongoing.

BEYOND ENGINEERING EDUCATION

Vigeant considers herself first and foremost a teacher, but she also conducts chemical engineering research unrelated to education (though she typically involves her students in that research). Since leaving UVA, she has continued her research into bacterial adhesion but took it in a new direction to study how E. coli flagella move. To do so, she worked with colleagues to build for Bucknell a total internal reflection aqueous fluorescent microscope.

She has collaborated with Ewan McNay, assistant professor of behavioral neuroscience at The University of Albany (SUNY), on their research measuring *in vivo* neurochemistry with microdialysis by creating a mathematical model of the brain-probe environment. The tool created by her and student Damon Vinciguerra has confirmed that the underlying assumptions being made by the neuroscientists were valid, and has provided new insight into the parameters that affect microdialysis measurements. "Without this tool, we had no way of knowing whether the data we were getting out was accurate. Margot's work has general applicability to all microdialysis studies," McNay says. "Working with Margot, I found her to be very responsive and highly knowledgeable, and she has excellent writing skills. I wish I had more colleagues like her." Others who have worked with her express similar sentiments, and she gets high praise on student evaluations as well. As Ford, her dissertation adviser, recognized early on, she is the complete package: a loving daughter, sister, wife, and mother; a scholar of the highest caliber; a creative thinker; a faculty member who serves her university in myriad ways; and a highly effective, committed teacher who is dedicated to advancing the scholarship of engineering education. ❐