Progress report:

WOMEN MOVE INTO SCIENCE LEADERSHIP

By Cristine Russell '71

There is a dreadful highway accident in which the father is killed and the son, critically injured, is rushed to the hospital. There, the surgeon comes to examine the patient and says, "That's my son!"

How can this story be true?

Mills College Trustee Cristine Russell '71 is a senior fellow at Harvard's Belfer Center for Science and International Affairs. She is president of the Council for the Advancement of Science Writing and has written about science for 35 years, including a stint at *The Washington Post*.

When former Mills President Robert Wert posed this riddle to Mills students and alumnae in the early 1970s, they had trouble solving it. Today, the answer is obvious: the surgeon was the boy's mother. Thirty-five years ago, the likelihood of a woman in the United States being a doctor was less than one in ten. Today, nearly half of all medical school graduates are women.

When I first wrote about women in science in 1971 as a Mills senior majoring in biology, my classmates were among a small but growing group of women going into science and medicine. Since then, things have certainly changed for the better as new opportunities have opened up for women entering a variety of scientific and engineering fields.

Women now earn more than 40 percent of bachelor's and doctoral degrees in science and engineering. But once they enter the scientific workplace in academia, business, and government, women continue to face a variety of subtle and overt obstacles to success.

Concern about the paucity of women who finally reach the top led Mills President Janet L. Holmgren to tackle the issue in 1994. With help from a national advisory committee, Mills hosted the first national Women in Science Summit, in which 52 of the nation's leading women scientists came to campus to brainstorm about ways to break through the "glass ceiling" of science. It was a remarkable experience for those of us who helped organize the meeting.

The resulting report, "Advancing Women's Leadership in Science," provided an action plan for both the public and private sectors. Recommendations included initiating new recruitment and retention efforts for senior science positions, assuring comparable salaries for female and male scientists, promoting effective mentoring systems for women, improving work environments and supporting career flexibility, heightening visibility of women in science, enhancing research funding for women in science, and, lastly, increasing accountability by tracking the advancement of women in science.

Since then, several summit participants have climbed to the top of their professions. Molecular biologist Shirley Tilghman, a member of the 1994 advisory committee, became the first woman president of Princeton University. Microbiologist Rita Colwell became the first woman director of the National Science Foundation, the top U.S. research institution. Locally, Ann Arvin advanced at Stanford University to become vice provost and dean of research in addition to her duties as professor of pediatrics and microbiology.

But these notable achievements are still the exception, not the norm. So when plans got underway to celebrate Mills' new Natural Sciences Building, we wanted to take the pulse of top women in science to assess how much progress has been made. As the moderator of a panel of distinguished women scientists who convened at Mills on October 11, 2007, for the building's dedication, I was struck by how hard women still need to work to get to the head of the science line.

"We've made a lot of progress, but still have a long way to go," said University of Maryland Professor of Chemistry and Biochemistry Sandra Greer, who chaired the 1994 summit. She noted, for example, that federal research grants to women are still far smaller than those given to men.

"Real change has happened. Women do succeed,

PHOTOS BY PEG SKORPINSKI

Gaining momentum: **Chemist Sandra Greer, pediatrician Ann Arvin, physicist Ticora Jones, and biologist Lisa Urry (top to bottom at right) relayed their experiences as successful scientists at a panel discussion hosted by Cristine Russell on October 11, 2007. The event, held in conjunction with the dedication of the new Natural Sciences Building, builds on the College's commitment to advancing women in these fields.**

and they do emerge as leaders," said Stanford's Arvin, who received her MD in 1972. She said that her generation of women had the strong conviction that they could have it all, both careers and families. "We're in leadership positions now," said Arvin, "but we have to remain vigilant." She worries that the glacial rate of turnover of tenured professors and reduced federal research funding may make it even harder to advance women through the academic ranks.

Another panel member, Mills' Biology Department Chair Lisa Urry, recalled that she was so impressed when she attended the 1994 summit as a Berkeley postdoc that she came to work at Mills the following year. She is concerned that women are still "leaking out of the pipeline at all stages and are underrepresented at the upper levels of all scientific fields."

The youngest member of the panel, Ticora Jones, a postdoctoral fellow at Lawrence Livermore National Laboratory, said mentoring was crucial for women in grad school. Jones has overcome additional obstacles as an African-American scientist; scientific PhDs going to women of color are still less than three percent of the total. She got a boost from an American Chemical Society high school program encouraging minority and disadvantaged students to go into science and was later honored when the Ticora Jones Trailblazer Award was created for program participants who go on to get doctorates.

The status of women in science is one policy issue that is receiving attention once again in the nation's capital. Last year, the National Academies of Science in Washington issued a report, "Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering," which found that women science faculty members continue to be paid less and promoted more slowly, receive fewer honors, and hold fewer leadership positions than their male colleagues.

Echoing the concerns of the 1994 Mills summit report, the 2006 Academies report said that the culture and outmoded system for advancement are still biased against women scientists at every step along the way in recruitment, retention, and promotion. The Academies committee called for "fundamental changes" at America's colleges and universities, as well as in the private sector, to make the scientific climate more hospitable to the advancement of women, including more flexibility in promotion timelines, increased support for those with children or caregiving duties, and better data collection and monitoring across institutions.

Texas Congresswoman Eddie Bernice Johnson recently introduced the Gender Bias Elimination Act of 2007, and a congressional hearing examined the issue. The proposed legislation would require federal science funding agencies to hold mandatory national meetings on gender bias for university department chairs, grant review boards, and government officials; increase enforcement of non-discrimination laws; and conduct compliance reviews to evaluate how institutions are doing.

Keeping the spotlight on women's progress towards scientific leadership in the 21st century is an ongoing job. In the 1970s, many of us thought that the feminist revolution would make it easier for women in all fields, including science, to rise rapidly to the top of their professions. Unfortunately, the road is rockier than we imagined and the pace far slower.

It will take more than meetings, reports, and bills to achieve real advancement of women into scientific leadership roles. It will require hard work by thoughtful men and women who are willing to reach down and help the women climbing the ladder below them. We need to keep the scientific leaders of tomorrow, many of whom are studying at Mills this very moment, advancing one rung at a time.

IT'S SO EASY BEING GREEN

The new Betty Irene Moore Natural Sciences Building announces its intentions clearly and eloquently: within moments of stepping through the arbor-shaded front door, one is drawn to features that showcase achievement, inspiration, conservation, and sustainability.

The building underscores the College's commitment to preparing women for success in science and, to encourage interdisciplinary study, brings together programs in psychology, biology, biochemistry and molecular biology, biopsychology, chemistry, and environmental science. It houses state-of-the-art teaching facilities but is distinctly unpretentious in keeping with the scale and demeanor of the surrounding campus. "We have evolved a vision for educating women in the sciences—this building is green, it is beautiful, and it is modest," said President Janet L. Holmgren at the building's dedication on October 11, 2007.

The campus has good reason to be proud of this newest addition. Going well beyond a few solar panels on the roof—although the photovoltaic system provides 30 percent of the building's electrical needs—the Natural Sciences Building's intensively energy-efficient design has earned a platinum rating from the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) system. The $17.2 million structure is the first building in Oakland to achieve such distinction. It is almost 90 percent more energy efficient than a typical lab in the Bay Area and 45 percent more energy efficient than required by state law.

The building was designed by San Francisco-based EHDD Architecture, campus architect Karen Fiene, and design consultant Peter Dodge. "We thought about sustainability from day one," says Fiene. "It saves money, and it's good for Mills and for the environment."

PHOTOS BY CESAR RUBIO

▲ **The soaring two-story lobby** greets students and visitors with a multimedia exhibit of accomplished women in science, such as Rachel Carson and Marie Curie, along with profiles of several Mills alumnae who have gone on to successful science careers (see excerpts from this display on page 19). Low-impact materials have been used throughout the construction, from sustainably harvested wood and locally sourced basalt stone to recycled carpet and fabrics.

▶ **Classrooms** are designed to keep students comfortable and alert. Tiered seating provides good sight lines and slightly angled walls with sound-absorbing panels ensure that lectures can be heard clearly. Abundant natural light streams through large windows overlooking the campus, and automatic sensors switch electric lighting on or off in response to conditions in the room. Additional sensors monitor the air and, as carbon dioxide levels rise (a leading cause of drowsy students), automatically increase the flow of fresh air to vents placed strategically in the floor.

▲ **Courtyards** surrounding the building have been reinvigorated with native drought-tolerant plantings, with a stunning fountain as the centerpiece. But look more closely, and the fountain's true nature is revealed: this sculpture collects rainwater, which is then filtered and purified before being used in restrooms. The system, in conjunction with other water-saving devices, is expected to save more than 335,000 gallons of water each year.

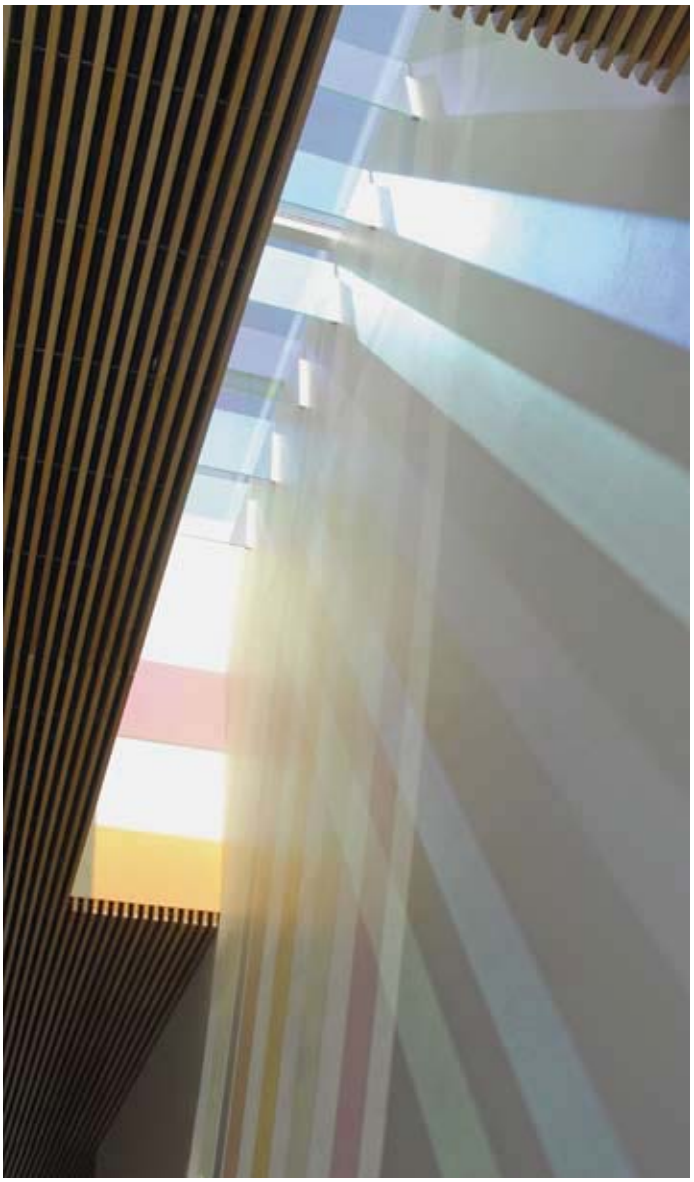
A core value in our planning was to incorporate opportunities for learning about science by using the building as a teaching tool.

–Karen Fiene, campus architect

Laboratories are similarly geared for health and safety. Light gray countertops reflect available light better than traditional black lab surfaces, recycled rubber flooring is comfortable underfoot and reduces fatigue, and even the stools from the old labs have been salvaged and refurbished. The organic chemistry lab sports seven fume hoods, a spectrometer, and other up-to-date learning tools.

The laboratory ventilation system creates a negative pressure so that the air is filtered and refreshed at least six times each hour. This system also ensures that any possible chemical spills are contained and removed as quickly as possible. These labs will save as much as $20,000 in energy costs annually.

A **skylight** set with panels of dichroic glass breaks sunlight into component colors, casting a changing light mural across the second floor lobby as the sun passes overhead. "A core value in our planning was to incorporate opportunities for learning about science by using the building as a teaching tool," says Fiene. "We wanted the green qualities to be visible, artful, and engaging."



Dana Davis

BEING GREEN

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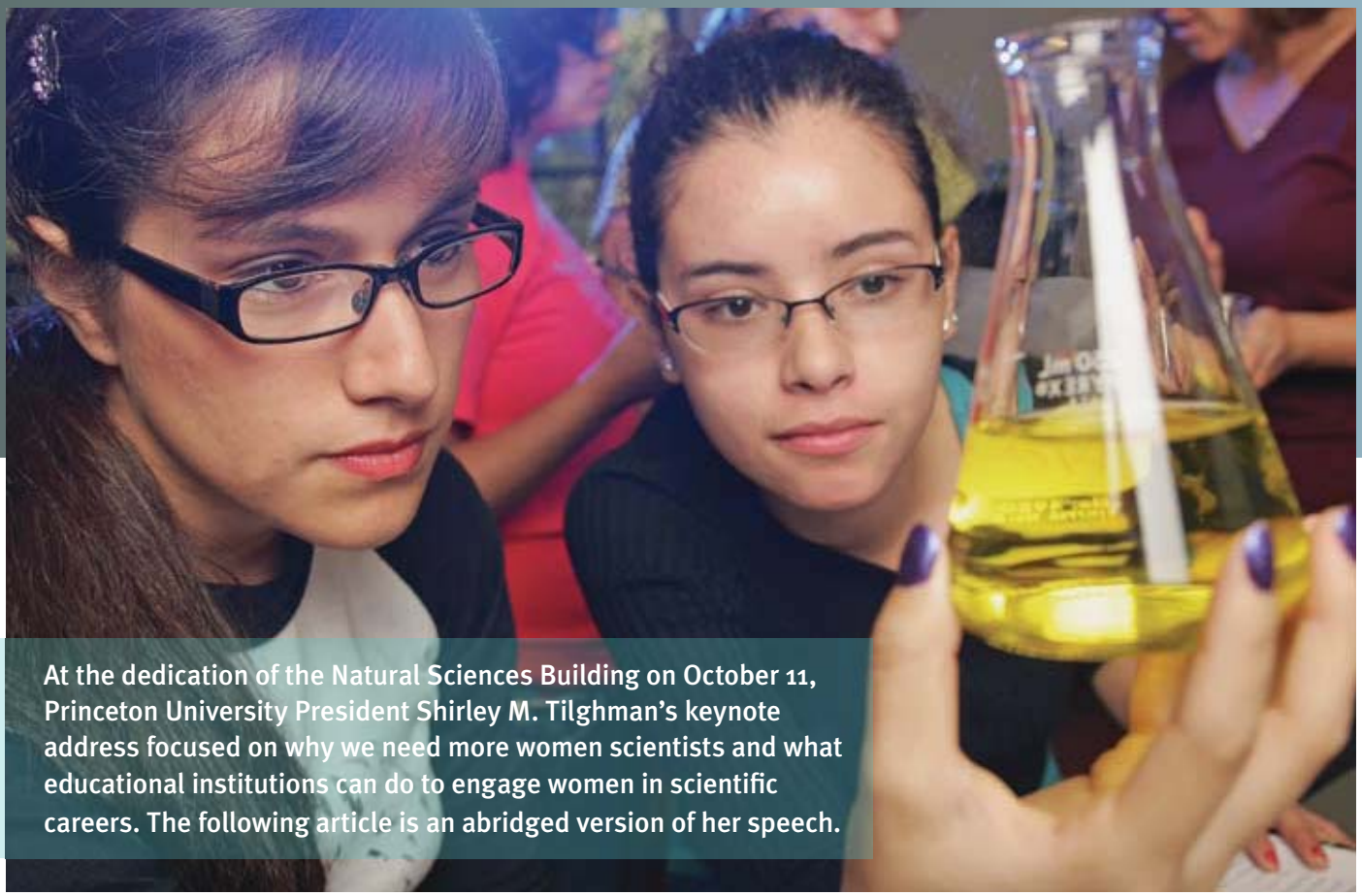
Opening Doors & Minds:

Attracting women to the sciences and engineering

By Shirley M. Tilghman

Philip Channing

If educators are to open doors and minds in ways that will attract more women to science and engineering, we need to clearly articulate the arguments for doing so; understand the nature of the obstacles that women face when contemplating a scientific or engineering career; and develop ways to overcome, or at least reduce, these obstacles. And we need to ask ourselves if we are teaching science in a way that is both inspiring and engaging to girls and young women.



At the dedication of the Natural Sciences Building on October 11, Princeton University President Shirley M. Tilghman's keynote address focused on why we need more women scientists and what educational institutions can do to engage women in scientific careers. The following article is an abridged version of her speech.

Philip Channing

Four arguments for women in science

Why should our nation be concerned about the gender of its scientists and engineers? After all, the United States has clearly enjoyed a dominant position in the international scientific community without the full participation of women. But, since the end of World War II, the staggering success of the United States' economy has depended to a very significant degree on using taxpayer dollars to support fundamental and applied research. The creativity and technological innovation catalyzed by this sustained federal investment resulted in ideas and inventions that have significantly improved our way of life. This government/university/private partnership resulted in new industries—from biotechnology companies to microchip producers to telecommunications firms—that economists estimate account for 40 percent of the increase in economic prosperity in the second half of the 20th century. For this partnership to thrive in the 21st century, when the competition for international scientific pre-eminence is going to be stiff, we have to attract to science and engineering more than our fair share of the world's best minds. To restrict our pool of talent, either intentionally or unintentionally, by discouraging women—or underrepresented minorities, for that matter—from pursuing careers in these fields is to guarantee that the outcome, and thus the future well-being of the United States, will be significantly less successful than it could be.

The second argument for expanding the ranks of female scientists and engineers is that the scientific interests of women are not always completely coincident with those of their male colleagues. I am not suggesting that women conduct scientific inquiry differently from men—the scientific method is universal—but it has been my experience that the problems that intrigue women are not always exactly the same as those that attract men. By encouraging women to embrace a life in science or engineering, we are likely to increase the range of problems under study, and this will broaden and strengthen the entire research enterprise.

The third argument in favor of increasing the number of women engaged in scientific and technological pursuits also appeals to the self-interest of the field itself: If women continue to be underrepresented in disciplines such as physics, mathematics, engineering, and computer science, these fields will look increasingly anachronistic to both male and female students, and we will risk losing the most talented among them. As law, medical, and business schools reach gender parity in their student bodies, our nation's science departments and engineering schools will become increasingly unattractive vis-à-vis those fields.

Finally, it is simply unjust for a profession to exclude a significant proportion of the population on the basis of gender. For every girl who dreams of becoming a scientist or engineer, there is a moral obligation to do everything we can to even the playing field so her chances rest on her abilities and her determination, just

as they do for her male counterparts. It is not sufficient for educational institutions to shrug their shoulders, invoke historical reasons for the situation, or bemoan the difficulty of changing masculine cultures.

Counteracting social and systemic obstacles

The underrepresentation of women in science and engineering has many causes, which have been hotly debated over the last several years. Many studies document the influence of social norms, rooted in childhood, when boys and girls confront divergent parental, scholastic, and societal opportunities and expectations. Social psychologists have exhaustively documented the disparate experience of males and females pursuing studies in male-dominated disciplines, particularly in fields where there is a cultural assumption that women are less able. The existence of such assumptions can lead to "stereotype threat," a phenomenon in which targets of stereotypes perform less well when they believe that their performance may confirm a negative stereotype about a group to which they belong. Psychologists Michael Inzlicht and Talia Ben-Zeev looked at the mathematical performance of male and female undergraduates in mixed and single-sex groups. They found that women performed more poorly in the presence of men than they did when men were absent—and that this deficit actually grew as the number of men increased. Men, in contrast, were unaffected by the number of women in the room. Unfortunately, the women most likely to suffer in such circumstances are those with the greatest ability, precisely because they are so intent on disproving the negative stereotype. This may help to explain the fact that the gap between male and female scores on the math SAT is largest in the most gifted population. It also explains why single-sex institutions like Mills have produced a disproportionate number of scientists in the past.

So, how do we make science and engineering more inclusive?

The first and most intractable obstacle that many young women face, even as early as high school, is the sheer fact that they are sometimes overwhelmingly outnumbered. It will not be possible to erase stereotype threat until we enhance the number of female scientists and engineers. While strategies to overcome this difficulty vary widely—from exposing the dangers of stereotype threat to those at risk, thereby blunting its effects, to positive reinforcement through mentoring, to single-sex instruction—all should affirm the abilities of girls and young women while challenging them to exceed their present level of achievement.

I attribute my own resistance to the stereotypical view that women are not meant to do science to four things: an extraordinary father who taught me that I could do anything I wanted, highly supportive mentors who happened to have been men, strong and inspirational senior women colleagues, and an absolute inability to recognize reality. Let me amplify the last point. It has been my experience that many successful women in science and engineering simply fail to perceive that there are obstacles in their path. They are able to go through life with metaphorical blinders on—not in the sense of denying that there are forces working against the progress of women, but rather in the sense of refusing to acknowledge that those forces apply to them. Such women refuse to allow themselves to become victims. This is a tremendous survival tool, but one that takes the kind of self-confidence that only comes from having strong parents, teachers, and mentors. We should be encouraging this trait in girls and young women, rather than engaging in a lot of handwringing about how tough things are.

On the other hand, we should not underestimate the degree to which the culture of science can be experienced as hostile to girls and young women. Some years ago, I helped organize a Gordon Conference. With my male co-chair, we put together a list of 45 speakers, a third of whom were women. The next year, the same co-chair organized the same conference—on the same topics—with a male co-chair. When their list was published, 43 of 45 speakers were men. What had happened in just one year? The difference is that when I close my eyes and think "stellar scientist," I can easily imagine a woman. When my colleagues closed their eyes, they saw only a man. This is not evil, it is human nature. This stereotype is as powerful in the mind of a 13-year-old girl as it is in the mind of a university faculty member, and it needs to be challenged wherever it raises its ugly head.


Peg Skorpinski

A world leader in the field of molecular biology, Shirley M. Tilghman served on the Princeton faculty for 15 years before being named university president in 2001. A native of Canada, Tilghman received her honors BSc in chemistry from Queen's University in Ontario and her PhD in biochemistry from Temple University in Philadelphia. She participated in cloning the first mammalian gene during postdoctoral studies at the National Institutes of Health and continued to make breakthroughs as an investigator at the Institute for Cancer Research in Philadelphia. She has also been an investigator with the Howard Hughes Medical Institute, a founding member of the National Advisory Council of the Human Genome Project, and is the founding director of Princeton's Lewis–Sigler Institute for Integrative Genomics. In 2002, she received the L'Oréal–UNESCO For Women in Science award and the following year received the Lifetime Achievement Award from the Society of Developmental Biology.

Creating passion for Big Ideas

Let us also consider the ways in which we can promote women in science and engineering through the nature and quality of our teaching. All instructors should encourage girls with a passion for science, mathematics, and engineering, and they should counter negative stereotypes by calling attention to successful women in science. But my greater fear is that we are no longer instilling in children and young adults a sense of curiosity about the natural world that would lead them to devote their lives to revealing its marvels—and that we are failing to provide them with the knowledge to make them good scientists and engineers.

So what induces a young woman to become a scientist?

What turned me into a scientist was discovering a Big Idea. I was a chemistry major at Queen's University in Canada, and, by my junior year, I was a bored chemistry major. Then, quite by chance, I stumbled on a paper in the chemistry library in which Matthew Meselson and Frank Stahl reported on the mechanism by which DNA is replicated. The first thing that struck me about the paper was the importance of the question, but what was absolutely gripping was how the two scientists distinguished among the options. The experiment they devised was clever, indeed elegant, and it led to an unambiguous answer. I ran over to the biology department to sign up immediately, despite the fact that I had never taken a biology course in my life—not because of what they learned but because of how they went about it, how they discovered new knowledge about the natural world. It was a thing of beauty and worthy of a life's work.

We must introduce students to the Big Ideas of science early in their education. Too often the operating metaphor for science education is a pyramid. At the bottom is a group of foundational facts that are often taught as a laundry list, without much effort to explain their relevance to modern problems. Only after you have successfully conquered those facts are you allowed to move up the pyramid to the next set of slightly more complex facts, and if you have the persistence of Sisyphus and the patience of Job, you will finally reach the summit and be shown why you have been learning those facts—that they are the tools you need to solve exciting big problems. We need to invert that pyramid and begin with the Big Ideas, and then continually connect the facts and theories and hypotheses we teach to solving the questions behind the Big Ideas.

I tried this approach some years ago with a group of freshmen in a seminar called The Role of Asymmetry in Development. I began the semester by posing one of the central questions in developmental biology. For the first three weeks, the students were forbidden to consult any textbooks or sources; I wanted them to think originally about the problem. We spent the rest of the semester reading papers from the professional literature in which their ideas had been tested. The students were able to understand the concepts and, most importantly, the ways in which scientists design experiments to test Big Ideas—their ideas.

My greater fear is that we are no longer instilling in children and young adults a sense of curiosity about the natural world... and that we are failing to provide them with the knowledge to make them good scientists and engineers.

The delight of discovery

Science is, at heart, an exercise in asking questions, and in the course of my career, I have always found designing and carrying out clever experiments to be far more engaging than the answers to which they ultimately lead. Answers are, of course, important, but the real excitement and the lasting rewards of a life in science come from the journey. This suggests that we educators need to abandon the practice of reciting the facts that reside at the bottom of the pyramid and replace them with questions—why they are important and how they are answered. This also suggests that we need to give students research opportunities as early as possible. In fact, studies establish a positive correlation between an early research experience and the likelihood of persisting with a career in science. This is hardly surprising since one of the greatest motivators for a scientist is the thrill of discovery.

By conveying to students the mystery, the joy, and the relevance of science to our world, we will not only strengthen our nation's scientific enterprise, we will attract larger numbers of female scientists and engineers. It is not sufficient to address the gender-specific hurdles that block the path of women in science and engineering; we must also rethink the pedagogy of science itself. If this re-evaluation is coupled with an unqualified commitment to creating an inclusive and supportive environment for female scientists and engineers, I am confident that the world of science will be fairer, stronger, and more fulfilling for all. I am also confident that Mills will continue to enhance its 155-year-old mission of helping women to fulfill their intellectual potential and that the students who gather in your new Natural Sciences Building will help to change the culture of science even as they explore its limitless frontiers.

Forces of nature: Mills alumnae scientists

The lobby of the Betty Irene Moore Natural Sciences Building features a dramatic two-story video installation that tells the stories of pioneering women in science—including Mills alumnae who are paving the way for the next generation of women to move into science leadership. The excerpts below were taken from that exhibit, Women Hold Up Half the Sky, which was made possible by a generous gift from Cristine Russell '71 and Ben Heineman Jr.

Patricia Babbitt '79

Research scientist and professor of biopharmaceutical sciences and pharmaceutical chemistry at the University of California, San Francisco

I came late to science, having grown up in a conservative social environment in which young women were directed away from math and science and toward liberal arts. I dropped out of college in my junior year. I went back [as a resumer at Mills] eight years later; I had experienced enough poor-paying jobs and wanted to see if I could succeed in a technical field that required sophisticated training.

When I started graduate school, there were no tenure-track women faculty in my department and few at UCSF. I remember joking with a friend that since we didn't have any female role models, we were going to have to mentor ourselves! Now she is a full professor at the University of Texas, as I am at UCSF. Today, there are still too few senior women in academia. I chose to stay in academic science rather than industry because I love teaching and mentoring the next generation of scientists. I plan to continue teaching and mentoring in the classroom and in my lab as long as my career lasts.

Jill Fabricant '71

Mills College Trustee and founder and CEO of Vasix Corporation, a biomedical company working to develop new drugs to reduce complications of diabetes and other diseases

Most exciting for me are discovery and the unknown, the ability to design experiments that ask questions about life, and to be surrounded by intelligent people asking similar questions. It is an opportunity to understand at a fundamental level.

I worked for the chairman of the Department of Biology at Caltech, Dr. Robert Sinsheimer, who really introduced me to laboratory research. The next summer I worked for Dr. Max Delbruck, a Nobel laureate at Caltech, and had the opportunity to meet with him one-on-one for the summer. At that time he was in his 70s, but his mind was so active. He was a marvelous mentor. I also did a postdoc at the Pasteur Institute in Paris with Dr. François Jacob, another Nobel laureate, who educated me on European science, where experimentation is carried out after much more rigorous group discussion and thought.

Amy Ryken '85

Associate professor in the Graduate School of Education, University of Puget Sound, focusing on science education

I've been interested in science since I was very young; I loved exploring in the outdoors. Many people learn to hate science because it is often presented as a series of set facts rather than a process of continual exploration.

Science has given me a lens for understanding the world. Throughout time, people have tried to describe the world in which they live. We'll never fully understand the complexities of ourselves and our world, but I enjoy the search—and I enjoy the fact that questions lead not only to answers, but to more questions.

We still have a long way to go in terms of equity in the sciences for women and people of color. I've had many experiences in my career where I have been the only woman at the meeting table or in the laboratory. This is challenging because of the sense of isolation and the need I feel to prove my abilities. It is also discouraging because the conversations and research suffer from the lack of perspectives in the dialogue. My experiences of isolation have inspired me to mentor others so the search of science can benefit from a range of perspectives.

Deborah Kimbrell '72

Associate research geneticist in molecular and cellular biology at the University of California, Davis

Discovery is exciting—it is the driving force behind scientific inquiry. The feeling of finding out something that was not known before is without parallel. Two professors at Mills inspired me: Aline Kidd, professor of psychology, and Daryl Bowers, professor of biology. They taught me my favorite line about science, and how to live: science is about *how* to think, not *what* to think.

In addition, Dr. James Fristrom, professor—now emeritus—of genetics at the University of California, Berkeley, is a great role model; he exemplifies the highest standards of critical thinking. Being a graduate student in his lab was excellent training in science, career, and personal life. Dr. Barbara McClintock, a pioneering scientist who won the Nobel Prize, also inspires me. I spent only one day with her when I was a student in the 1970s, and it still affects me.

There have been many challenges related to gender, mainly from the subtle sexism that is ingrained in society. Overcoming those challenges has largely meant ignoring them and carrying on.