by IOANNIS N. MIAOULIS

encouraging

women in engineering, math, & science

I COME AS AN EMISSARY FROM one of Claudia Goldin's "male-intensive" majors. I am a mechanical engineer by training and, before I joined the Museum of Science, I was Dean of the School of Engineering at Tufts University. In these jobs, I have looked to promote women into leadership positions, and it has often been very difficult to find candidates. Thus I have spent a significant part of my career trying to increase the number of women studying engineering, science, and math.

My interest in encouraging young people to study engineering began in the mid 1980s when my wife and I moved to Boston. One day, I was trying to find my way to Tufts when I made a wrong turn and ended up in the parking lot of the local middle school. As I was looking around, it occurred to me that it would be fun to show the students some of the new materials we had made in the laboratory. IBM researchers had been working on new superconducting materials; magnets placed on them would float. Many of us thought this might lead to superconducting roads and magnetic cars, like in the TV cartoon show, *The Jetsons*. I got out of the car and met with the principal, who invited me back to talk with his eighth graders.

During the presentation, I planned lots of hands-on activities. To make the concept of electrical resistance understandable, I used the analogy of drinking a milkshake through a straw: the thicker the straw, the easier to drink the milkshake; the longer the straw, the more difficult to drink the milkshake. As I was giving my talk, a blonde girl with frizzy hair sat right in front of me, glued to everything I had to say.

At the end of my visit, I noticed the

teacher encouraging his "science boys," as he called them, to lobby me to help them build a superconductor. The little frizzy-haired girl cut right in front of them. "Dr. Miaoulis, I would love you to help me with my Science Fair project," she said. She wanted to investigate the fluid mechanics of milkshakes. As I was negotiating with her, the teacher pulled me aside and whispered in my ear, "Don't waste your time with her. She's a mediocre student. Why don't you work with the guys?" I was shocked.

I spent the next 15 years at Tufts focusing on making science and mathematics more exciting for young people in general, and young women in particular. The first hurdle: rethinking the K-12 curriculum, which had been set in 1892 when there were no airplanes, cars had just been introduced, and technology and engineering weren't on the radar screen. Today's curriculum focuses on the natural world but covers little about the human-made world where we spend most of our time. Inspiring today's students—women and men—would require a new approach.

I thought engineering would be a good way to get young people excited about math and science. Engineering makes math and science relevant to people, and it uses project-based and collaborative learning in which women tend to thrive. In an engineering project, you identify a human need and come up with a solution. For example, suppose a second-grade classroom has a pet bunny, but one student is allergic to rabbits. An engineering project would be to design and build an outside habitat. Students use math to make measurements and science to understand that insulation is necessary since heat travels from hot to cold. They have to communicate verbally and in writing—to collaborate with each other *and* to convince the janitor to let them put the bunny house outside!

But success would take more than an "add women and stir" approach. Other schools had tried to improve the representation of women in math and science by simply accepting more women students or hiring more women faculty, and expecting the rest to follow. Yet, retaining women was the real problem and this required a larger transformation.

Tufts engineering students tended to drop out before taking a single engineering course—because they said engineering wasn't interesting. So we decided to introduce engineering from the first year and in a playful way. Professors took their passions and developed engineering courses around them. My two passions are fishing and cooking. I taught a fluid mechanics course called "Life in Moving Fluids," which focuses on the physics of motion of fluids but from the point of view of a fish. I also taught "Gourmet Engineering," a heat transfer course, with the experiments done in a kitchen. We also introduced design courses early to even up the experience gap that boys have over girls prior to college. Traditionally, women have had more difficulty than men in

visualizing things in three dimensions. Research suggests this is the result of the toys that girls play with compared to the toys that boys play with, and that early design courses can bridge the gap.

Along the way, we instituted other measures. We established a national web database (www.wieo.org) for women-in-engineering programs. We created innovative summer programs for high-school girls, and a program that pairs middle-school girls with Tufts engineering students and faculty to work at a local museum. We increased the representation of women on Tufts faculty to serve as role models and mentors. We also paid attention to things which are sometimes overlooked, like creating more women's bathrooms in buildings built when only 3 percent of engineering students were women. We changed the culture in a fundamental way.

And an amazing thing happened. Tufts became the only engineering school in the country that attracted more students from liberal arts than it lost to liberal arts. Today, 32 percent of Tufts engineering students—about twice the national average—are women; and 16 percent of the faculty are women, about four times the national average.

And in case you're wondering, the little girl with the frizzy hair won the science fair that year; in fact, she was the first of five girls in a row to win at her school, an unprecedented event. She eventually attended Haverford College and majored in history and biology, graduating with honors. Today, she works in Tanzania for her own nonprofit foundation that raises money, and designs and builds science laboratories for children. ❊

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by PAUL F. LEVY

teamwork

on the field & at work

ONE WAY THAT PEOPLE LEARN TEAMWORK, informal mentoring, and other workplace skills is through participating in sports. Yet, many women of my generation did not get a chance to develop these talents since they had fewer opportunities to participate in organized athletics when they were young. I came to understand the importance of sports from my own experience: My passion—all the rest is a hobby—is coaching girls' soccer, something I have done for the last 15 years.

My goal as a coach is to create an environment that rewards risk-taking, discourages criticism, and acknowledges the girls' desire to have social relationships while they play. In this environment, the girls gain prowess and confidence, and their individual satisfaction rises. They become more and more creative—trying out different approaches, fresh moves, new ideas—because they know they are not going to be criticized. Over time, what I would call the "explicit social intercourse" also grows, as girls from a variety of backgrounds become at least friendly, if not real friends.

But here is the magic. Imagine 22 kids moving around on the field. Eventually, the girls learn to place themselves as play develops during a game in a way that reflects their relative strengths and weaknesses as players. They do not have to be told to do this. They do it on their own, on the field. They talk to one another occasionally, but mostly it happens intuitively.

The result: a team that is truly greater than the sum of its parts. The players function as a cohesive group—going from offense to defense, left to right, one side to the other—and the team works as an organic whole. When mistakes are made, you hear, "Good try." Or, "Don't worry about it. It'll be better next time." And when successes happen, players are covered with compliments from everyone. And, most important, the girls are smiling when they leave the field, win or lose.

These lessons from the playing field also apply to companies and institutions. Mentoring works best when it happens informally with the person who happens to be standing next to you when you need it. A work environment that encourages risk-taking, discourages criticism, and supports social relationships will allow and encourage women to develop their skills and achieve high-level satisfying careers. And, the interesting part is that men like it, too. ❊

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