FORGING A FUTURE

UW–Stout Professor Brenda Puck Teaches Science and Self-Esteem at STEPS for Girls

BY JULIA LEHMAN CALDWELL

“What kinds of everyday kitchen products go from a liquid to a solid?” asks Puck. Twenty seventh-grade girls stare at her, their cheeks flushed and their hair damp and stuck in clumps. All have safety glasses on and they are fogging up, rimmed with steam. After a few moments of silence, some hesitant responses emerge from the group.

“Jell-O?”
“Cake?”
“Ice cubes?”

“You got it! Most of you are casters and you didn’t even know it,” says Puck, smiling. Her eyes gesture toward a table of shiny metal artifacts, cast by previous students: book ends, plates, goblets, and paper weights. “Our liquid, when poured into a mold, is turned into solid products like jewelry, engine parts, faucets, and dental molds.”

It’s a stormy, 80-degree July afternoon, and the temperature in the University of Wisconsin-Stout foundry feels like 110 degrees. Proper gear is required when working with molten metals, so everyone wears jeans, T-shirts, tennis shoes, and safety glasses. Someone propped a door open, attempting to let in a breeze, but the foundry remains sticky and noisy, filled with the heat of an enormous 1,400-degree electric furnace and the vibration of a massive, overhead ventilation system. The foundry even smells hot, like the acrid fumes of a potholder forgotten on a stove burner.

Today, Puck’s girls are casting aluminum nose cones for their radio-controlled model airplanes. “Does anyone remember my acronym?” Puck asks. “M&M. Melting and molding.” Beads of sweat multiply on foreheads and pool in safety glasses as Puck summarizes lost foam casting. “We will create a mold for the nose cone from Dylite foam, place the mold in a box called a form, and then pack the form with a type of silica sand. Finally, we’ll pour molten aluminum into the form, burning out the foam mold and creating the aluminum nose weight.”

Puck grabs a ball of dylite foam from a cardboard box and passes it to the girls. “What does this remind you of?” she asks. This time a response comes almost instantly.

“Styrofoam?” one of the girls answers.

“Exactly!” Puck taps her fingers against the ball, and it sounds like knuckles knocking on wood. “only it’s more solid—it’s denser, isn’t it?”

Puck’s hands, with slightly enlarged knuckles, reveal years of working with her father in his welding lab, where they would take apart lawnmowers, watches, and airplane engines. As a technology instructor at UW–Stout, Puck teaches casting and materials design to manufacturing engineering students. But when the college students all leave for the summer, she stays on campus to teach for the Science, Technology, and Engineering Preview Summer (STEPS)
The Science Technology and Engineering Preview Summer (STEPS) program at UW-Stout is a one-week camp for 6th- and 7th-grade girls. The cost is $325 per participant. There will be four summer sessions in 2009 with forty campers each, and one advanced session before the fall semester begins. For more information on the program, visit uwstout.edu/ctem/steps.

program for seventh-grade girls. For one week, STEPS girls participate in a variety of workshops that give them hands on experience with high-tech equipment and processes. Outstanding professors from the engineering, technology, and sciences programs at UW-Stout teach the summertime workshops, which also include such activities as bowling, swimming, a pizza party, and karaoke.

Seeing Puck and the STEPS girls in the hot, noisy foundry, melting and molding aluminum, doesn’t just seem unusual—it is unusual. In the engineering field, the lack of female engineers is a familiar reality; although women make up nearly half—46% as of 2007—of the American labor force, approximately 10% of engineers are women, according to the U.S. Department of Labor. In fact, women are underrepresented in most careers that require knowledge of science, engineering, and math, and are instead clustered in traditional “pink collar” fields that limit their earning ability. The American Association of University Women (AAUW) estimates that women earn only 77 cents on the dollar to their male counterparts: over a working lifetime, this wage disparity can cost the average American woman from between $440,000 to $2,000,000.

But there are more than just economic consequences to this employment disparity. According to Jane Margolis and Allan Fisher in Unlocking the Clubhouse, it was predominantly male engineers who designed the first generation of automotive airbags to fit adult male bodies, who sized the first artificial heart valves to correspond to the male heart, and who calibrated early voice recognition and video conferencing systems to recognize typical male voices. At best, a product designed by a group that is not representative of its users can be an inconvenience. At worst, these products pose a serious danger to those users who are underrepresented in the design process.

Yet throughout history women have played an integral role in the development of technology. Casting has been around since early civilization; the Greeks and Romans credited women for inventing it, naming the goddess Athena as the inventor of all mechanical arts, including the yoke and bridle, the sailing ship, and the flute and trumpet. Women have also invented the circular saw, the windshield wiper, the fire escape, the electric water heater, Liquid Paper, Kevlar, Scotchgard, even the first computer program. Although women have made many significant contributions to technology, few pursue careers in technology.

The STEPS camp is proof that things might be changing. On this sweltering afternoon in the foundry, the once-quiet STEPS girls are getting first hand experience in the world of technology. They chatter away as they place foam nose cone molds into the two-piece forms and then fill them with the black silica sand. Dressed head-to-toe in protective gear—a face shield, massive leather gloves, a fireproof body suit, and shoe protectors—Puck leads the girls to the large cylindrical furnace that holds the molten aluminum. She beckons the girls to come closer, holding the face shield over the circular opening so that each girl can peer down the shaft at the glowing crucible of molten aluminum.

“What does it look like?” she shouts over the noise of the fans.

“Lava?” one of the girls answers.

“Do you know how hot molten aluminum is?” Puck asks. “Water boils at 212 degrees Fahrenheit. The aluminum in the furnace is almost 1,400 degrees Fahrenheit. That is really hot, isn’t it? How warm do you think the air in the room around us is? Much cooler than the aluminum, isn’t it? So what’s going to happen when that molten aluminum hits your mold?”

The wide-eyed girls shout out answers.

“Fire?”

“Smoke?”

Puck affirms their answers. “Yes, you’ll see lots of sparks and ash as that molten aluminum burns out your mold and replaces it with molten aluminum.” She presses a control on the furnace, and the cylindrical shaft rises up and rotates 45 degrees clockwise, exposing the crucible of molten aluminum on a circular, concrete platform. Puck ladles the molten aluminum into the forms. Sparks, ash, and cinders fill the room and lazily float out the open foundry door. The silica sand holds the cooling aluminum in the shape of the nose cone.

By the final phase of loss foam casting, the girls are excited and engaged, showing interest with only a little encouragement from Puck. The foundry hums with a boisterous racket as the girls locate their forms and then rip them apart with long metal tongs in a race to find the hidden treasure. The dylite foam molds have disappeared.
and left behind steaming, finely textured aluminum nose cones. Ash and extinguished cinders flutter down like heavy snow and land, leaving black smudges on sweaty skin. The girls rinse their blistering nose cones in the foundry sink, and the hissing of steam adds to the cacophony.

“Never underestimate the power of casting,” Puck says, struggling to be heard over the excited conversations. They have much to talk about, having just witnessed a miracle of sorts: metal nose cones magically emerging from all that sand. In the foundry, where metals are melted and cast into molds, the world of manufacturing engineering has been revealed—and, perhaps, some manufacturing engineers will be cast this day as well.

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The UW–Stout STEPS program was created to help close the gender gap by introducing girls to the world of science, technology, engineering, and math (STEM) at an age when they still have time to take the middle school courses that are critical for high school and college math and science—and before they begin to believe that these careers are not for women. Indeed, research reveals how socialization, gender stereotyping, and even our STEM classrooms send young women the message that science and technology careers are not for them. Toys for girls tend to have hidden or low-key technologies that model domestic family scenarios, while the technology in toys for boys is overt and flashy, representing the prominent technologies in society. In our modern, post-industrial society we forget that domestic products like washing machines, sewing machines, and microwaves are technological. Yet the traditional STEM classroom is not inclusive for women, who tend to feel alienated by excessive competition, and who often relate to science and technology by first understanding its social context (e.g. how a technology might solve a social problem or improve our quality of life).

STEPS is the brainchild of Dr. Pete Heimdahl, UW–Stout Associate Dean of the College of Technology, Engineering, and Management. In 1995, Heimdahl observed this technological gender gap while searching for female technology professors for the new manufacturing engineering program. Out of the 114 instructors nationwide who taught the curriculum, only three were women. After the manufacturing engineering program began, the enrollment of female students averaged only 10 to 15%. So Heimdahl decided that UW–Stout would have to grow its own female engineers, and in 1997 the STEPS camp was born. “Somewhere in their young lives, girls are given the false message that they don’t have the talent or ability to follow careers in engineering, science, and technology,” says Heimdahl. “They begin believing it, which results in a severe shortage of women in these fields.”

At a time when female role models in STEM fields are still few and far between, Puck is not yet accepted as an innovative female STEM educator, but someday she will be—for she truly fits no mold. Puck has been involved with STEPS for ten of the eleven years of the camp’s existence. “[STEPS] is my baby,” Puck says with excitement, and just a hint of sadness. Puck is in her mid-thirties, single, and has no children. “It’s one of those weird blessings,” she says, commenting on the rigorous nature of the STEM work environment. “I can make a big impact in the lives of many young people. But with just one child—I wouldn’t be able to make that commitment.”

Looking around Puck’s office on the second floor of Fryklund Hall at UW–Stout, it’s easy to see her where her enthusiasms lie. Fastened to the walls,
WINTER 2009  WISCONSIN PEOPLE & IDEAS

in a restaurant at uW–Stout, Puck has lunch with Brianne Hartung, a 1997 graduate of the STEPS program and a 2007 graduate of the uW–Stout Packaging Engineering program. Hartung has a patent pending for an innovative, flexible shoebox packaging design that won her and two other students first place in the 2005 National Flexible Packaging Student Design Challenge. “I don’t know where I’d be today if it hadn’t been for the STEPS camp,” she says.

Hartung is one of five participants from the first year who decided to enroll in uW–Stout engineering programs. Other participants have enrolled in programs at such universities as the Air Force Academy, Massachusetts Institute of Technology, Michigan Technological University, and the Mayo Graduate School. While at uW–Stout, Hartung interned at three different companies: Ecolab gave her experience in industrial packaging; at Boston Scientific she worked with medical packaging; and she got an overview of food packaging at General Mills. Although her internships kept her away from STEPS for a couple of summers, Hartung still returns to STEPS whenever she can. She volun-
teeered in 2008 as head instructor for the packaging class at STEPS, with her time donated by her employer, General Mills. “I am a mom for the week,” she says, grinning from ear to ear.

Over the course of four weeks every July, four groups of forty middle school girls attend the STEPS camp. The girls live in the residence halls, eat at the campus cafeteria, and work in the science labs with college professors. The forty girls are divided into teams of ten, and each team is led by a female university-student counselor—often a major in engineering or technology. Hartung stays with the STEPS girls in the dorms—twenty-four hours a day, seven days a week—as they learn the manufacturing engineering processes required to construct a radio-controlled model airplane. The process includes hands-on activities that promote

Carrie Allen (now a STEPS instructor), Al Hildenberg, and STEPS founder Peter Heimdahl.

Photo credit: uW–Stout
success and self-confidence in core STEM areas: physics, chemistry, packaging, computer-aided design and manufacturing, metals casting, plastics processing, and robotics.

On the evening before camp graduation, the campers fly their airplanes with the help of a local model airplane club. In a UW–Stout online article about the tenth anniversary of STEPS, Hartung reminisced about the first time her airplane flew: “It was an amazing feeling... Something that I manufactured was flying hundreds of feet in the air. It gave me the feeling that I too could fly where ever my dreams would take me.” Hartung witnessed firsthand the changes in the STEPS girls. “It’s fun seeing the reaction girls have, from not knowing about technology to becoming excited about it. Their confidence really shoots up. It’s crazy. The change you see in one week. I still get cards from them throughout the school year.”

Hartung recalls a conversation between one of the STEPS participants and her engineer mother at the end of the one-week program: “Thanks, Mom,” the girl said. “Now I know why you love your job.” But to Hartung, STEPS is about even more than just changes. “It’s like what Pete [Heimdahl] says: we are teaching these girls it’s okay to be cute and smart.”

Heimdahl points to the fact that roughly 1,600 UW–Stout STEPS participants have manufactured and flown their own radio-controlled model airplanes. “More importantly,” says Heimdahl, in a UW–Stout online article about the tenth anniversary of STEPS, “1,600 young women have been influenced with the message that careers in engineering, science and technology are real and exciting opportunities for them.” The UW–Stout STEPS program has been reproduced at twelve universities and colleges in seven states, totaling over 4,000 graduates who have designed and manufactured their own radio-controlled model airplanes, robotic vehicles, even rockets that reach an altitude of 3,500 feet. For the first time in the history of the UW–Stout program, instead of manufacturing and flying model airplanes, STEPS participants created small radio-controlled boats that they launched in the Johnson Fieldhouse pool.

This proliferation and diversity of STEPS programs comes at a time when women are near to gaining equality in educational achievement. According to the U.S. Census Bureau and the AAUW, women have made significant gains in such nontraditional fields as biology, physical sciences, and math. Women now earn more than 60% of undergraduate degrees in biology and nearly half of the undergraduate degrees in math. The National Science Foundation says that women are also earning advanced degrees in higher numbers, composing one-quarter to almost half of the graduating doctoral candidates in the “Top 50” STEM-discipline departments: science, technology, engineering, and math. While the gains are palpable, women are still underrepresented in public sector and faculty STEM-related jobs—especially in engineering and computer science.

But there is cause for optimism. Through the power of positive female role models like Brenda Puck, and the real-world, gender-inclusive STEM instruction available at STEPS, more and more young women are embarking on STEM-related careers. It doesn’t matter if the world is prepared for them. Ready or not, here they come. ★

2006 STEPS campers show their finished airplanes.

Photo credit: UW–Stout