NJIT's Pioneering Women Chemical Engineers

Born in 1919, **Beatrice Hicks '39** knew by the age of 13 that she wanted to be an engineer. Decades into her pathbreaking career in sensor design, she urged "the young women of America" to follow in her footsteps lest the country miss out on their talents and suffer declining science standards as a result. Progress, she believed, depended on it. **General Ellen Pawlikowski '78**, who directs the 80,000-person Air Force Materiel Command for the U.S. Air Force, views her technical education as the foundation for learning how to solve problems – "to go into an area I know little about and, in a short period of time, translate that into making a contribution." **Elaine Gomez '14**, a graduate student who tests methods for reusing carbon dioxide that would otherwise be released into the atmosphere, sees chemical engineering as central to her mission. "We begin with chemical processes, which are small-scale, and engineering allows us to scale them up into power plants and chemical factories that make life better." Following are profiles of three NJIT alumnae who are pioneers in the field of chemical engineering.

'39 Beatrice Hicks

"Women having a high level of engineering ability must be recruited today if we are to avoid a tacit acceptance of lower and lower scientific and engineering standards tomorrow. Considering the huge number of new engineers we require each year, mediocrity cannot be avoided unless the young women of America, among whom half of our present and potential scientific talent lies, recognize and accept their responsibilities to develop their engineering abilities."

- Beatrice Hicks

Beatrice Hicks '39, an inventor, business leader and urgent advocate for women in engineering, was a pioneer in the field of environmental sensing devices. At the helm of the New Jersey-based Newark Controls, Inc., she designed and manufactured gas density monitors, called switches, to detect potentially dangerous leakages around electronic equipment in missiles, jets and Air Force instruments. Her sensors could anticipate equipment failures, locate them and gather information to correct them. Sturdy enough to withstand vibrations, shocks and extreme temperature variations, they were used in the ignition systems on the Saturn V rockets that launched the Apollo moon missions, on Boeing 707 aircraft in antenna couplers involved in long-range communications, and for monitoring nuclear weapons in storage, among other applications. She patented a molecular-density scanner and developed an industry model for quality control procedures.

Hicks also broke barriers for women in engineering. She was the first woman engineer employed by Western Electric who went on to run her own company and design sensors that made long-range air flight and space travel safer. She was the founding president of the Society for Women Engineers in 1950 and the chair of the First International Conference of Women Engineers and Scientists in 1964. At a space symposium for women, she told the audience, "The saying 'the world is yours to conquer' is no longer true. Yours is the universe." Her reputation and impact endure. This spring, she was inducted into the National Inventors Hall of Fame.

'78 Ellen Pawlikowski

"For the most part, even though we like to say engineering is a male-dominated field, I can tell you that I've met very few engineers who cared whether you were a man or a woman. They just cared about your capabilities. People asked if I had a hard time in class. I will tell you, whether it was at graduate or undergraduate school, I never had trouble finding a lab partner."

- Ellen Pawlikowski

Elaine Gomez '14

"The Intergovernmental Panel on Climate Change reported in 2014 that on our current trajectory we will reach a point where we will not simply have to curb emissions of carbon dioxide to avoid extreme ocean acidification, potentially catastrophic sea-level rise and severe impacts on human health. We will have to become carbon negative, meaning we will have to devise methods for removing it from the atmosphere and storing it. There are a lot of different avenues to accomplish this and I aim to strategically reuse CO_2 via alternative-energy catalysis."

- Elaine Gomez

Elaine Gomez '14, a Ph.D. student at Columbia University, is researching methods to reduce the amount of carbon dioxide (CO_2) released back into the atmosphere by converting the greenhouse gas into useful feedstocks such as compounds to create liquid transportation fuels or high-value olefins, molecules used in products ranging from adhesives to fibers. "Rather than becoming costly waste, CO_2 has the potential to become a liquid fuel that not only is compatible with existing infrastructure, but also contains higher energy density than competing solutions," says Gomez. Backed by a three-year National Science Foundation Graduate Research Fellowship, she is working with Dr. Jingguang Chen, the Thayer Lindsley Professor of Chemical Engineering at Columbia, to devise processes that don't rely on expensive metal catalysts. "One of the challenges we face is that carbon dioxide is a very stable molecule and so developing a catalyst that makes the compound highly 'active' is really important." She is also combining CO_2 with propane to make propylene, which is a high-demand chemical building block. The goal, she says, is to identify processes that have a significantly higher CO_2 input than output, while also creating a value-added product.

"I think our role as chemical engineers is to begin with the fundamentals and then work to apply them in many diverse fields, truly impacting everyday life," Gomez notes. "Among all the aspects of chemical engineering, my favorite is catalysis, which allows chemical processes that would otherwise occur at slow rates to occur at feasible production times and at large yields if needed. Catalysis plays an integral role in almost every chemical process we can possibly think of."

In 2015, Ellen Pawlikowski '78 was promoted to the rank of four-star general in the U.S. Air Force. Just the third woman in the branch's history to receive a fourth star, she directs the 80,000-person Air Force Materiel Command, whose stated mission is to "deliver and support agile war-winning capabilities." In addition to managing city-sized military bases, she directs the Air Force's investment in weaponry technologies: hypersonics — the ability to travel at extremely fast speeds of Mach 5 or 6; directed energy — lasers and high-powered microwaves that allow the military to "get power on a target from a very long distance"; and automated devices that can not only operate on their own and think, but also interact as a human that flies as a wingman would in the plane. She looks to additive manufacturing as the way of the future to support U.S. installations and weapons systems so that they can produce needed supplies and parts at the right time and place. As she puts it, "We make sure everybody has food, but we're also deciding on the look of the jet my granddaughter's going to fly when she's 25 years old."

During an earlier stint in the Office of the Secretary of Defense, she was responsible for chemical and biological counter-proliferation during Desert Storm, "trying to figure out what we needed to do to protect against biological agents, and one of the answers was to vaccinate people… My job was to make sure we had the right technical information to guide the decision."

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