MAKING A DIFFERENCE

FEMALE PERSPECTIVES ON ENGINEERING

Carnegie Mellon University COLLEGE OF ENGINEERING
ENGINEERING: THE APPLICATION OF MATHEMATICS AND SCIENCE BY WHICH THE PROPERTIES OF MATTER AND THE SOURCES OF ENERGY IN NATURE ARE MADE USEFUL TO PEOPLE.
BECAUSE OF ENGINEERS, commonplace objects like smartphones have become powerful computing devices that use location technology or GPS to connect us to friends and much more. Sensing devices on bridges can warn us of structural problems. New materials are being used in implantable medical devices that our bodies won’t reject. These technological feats are the results of innovations in engineering.

ENGINEERS ARE PROBLEM SOLVERS. Knowing how to apply mathematics is essential in engineering, but so is creativity. By looking at problems from different perspectives, smart solutions unfold. It is the combination of aha! moments and hard work that result in cars that drive themselves or technology that shields computers from cyberattacks.

ENGINEERS ADVANCE TECHNOLOGY, MAKING IT POSSIBLE FOR NEW BUSINESSES AND EVEN INDUSTRIES TO FORM. Think about the different companies that will arise as we pursue sustainable forms of energy. Outside of the lab, engineers help inform the public about the impact technology can make in our lives.

In the College of Engineering at Carnegie Mellon University, we believe that a career in engineering, which can be personally and financially rewarding, is attainable regardless of gender. Roughly 30% of the undergraduate students in the College of Engineering are female. In fact, nearly half of the undergraduates in Carnegie Mellon’s Civil and Environmental Engineering Department and Chemical Engineering Department are women.

OUR GRADUATES ARE KNOWN FOR THEIR IN-DEPTH TECHNICAL KNOWLEDGE. They are also prepared for leadership roles in the organizations where they are employed, wherever in the world that may be! Many of today’s challenges are global in nature, like climate change, and our students learn how to work within different cultures. We stress innovation, entrepreneurship and an interdisciplinary approach in our education and research. A degree from the College of Engineering can help you succeed whether you pursue a career in a corporation, academia or create your own startup company.

In this book, we introduce women who have accomplished much through their involvement with the college. We hope their stories inspire you to become an engineer. Someday your work could make a difference in the lives of people worldwide.
When Sangita Sharma enrolled in Carnegie Mellon University (CMU), she wanted to study a field that aligned with her love of chemistry, yet she was torn “between pure and applied science. I don’t want to just do research. I want to study things that have real-world applications and will help me get a job,” says Sharma.

She thought chemical engineering was her calling until she learned that chemistry plays a vast role in materials science and engineering. After thoughtfully exploring the two disciplines, she decided to major in materials, but with a twist—she would double major in biomedical engineering, too. Earlier, she had considered a career in medicine, and when she discovered she could apply “materials knowledge to biomedical engineering,” she grew excited. Working with her faculty advisors, she was able to create a program of study that combined her varied interests. Today Sharma is studying tissue engineering along with biomaterials and their applications, “I am confident there is a need for engineers with this knowledge.”

While she’s exploring her career options, she’s also learning how to develop new materials for medical use. These materials can be used in drug delivery systems that send medicines to specific places in the body. Novel materials are also needed to make implantable medical devices that our bodies won’t reject. Sharma is exploring the intersection between materials science and biomedical engineering to learn what interests her the most. College has proven to be a time of tremendous discovery for Sharma, both inside of the classroom and out. She has a passion for leadership and community development. For example, she served as Student Body Vice President and kept the university’s administration informed of student views and vice versa. “The knowledge I gained in student government is priceless. I learned how to work with people who have different goals and different ways of looking at situations.”

One of Sharma’s favorite extracurricular activities is working as a head orientation counselor. She belongs to a small group of upperclass students who serve as academic and social role models and mentor first-year students during Orientation. “I love Orientation, and I want new students to know that we have fun at CMU.” Through her activities, Sharma has made many friends, she’s honed her social skills and she’s gained tremendous confidence.
MATERIALS SCIENCE AND ENGINEERING
AND BIOMEDICAL ENGINEERING
In high school, Brittani Grant considered herself “a math and science person.” Her teachers agreed and nominated her for the New Jersey Governor’s School of Engineering and Technology, a summer program at Rutgers University. Grant earned a spot in the intensive program and spent a month immersed in engineering. “I studied earthquake technologies,” says Grant. She and her team constructed a model of a building and tested its design on an earthquake simulation table. “The table shook our model, and it didn’t collapse,” smiles Grant.

That summer she talked to different types of engineers. “I learned there are many career paths civil engineers can take. I discovered that I was interested in building construction,” she says. In her final year of high school, Grant competed in the first annual Association of Equipment Manufacturers Construction Challenge. Her team won a regional event and then travelled to Las Vegas to compete for the national championship. After that experience, Grant knew she wanted to be a civil engineer, but she didn’t know which college was right for her.

She decided to visit Carnegie Mellon University (CMU), and during a campus tour, she spied engineering students pouring cement for a deck. “I thought if those students can propose, design and build a deck before they graduate, I’m going to learn something here. That was my turning point. I was going to CMU!” says Grant.

Once at CMU, Grant threw herself into her classwork and got heavily involved in her sorority, Alpha Chi Omega, where she made friends who weren’t engineering students. “I like being around people who think differently than me,” she says. Her extracurricular activities were fun, and they, like her classes, helped prepare her for an internship at the construction site for the University Medical Center of Princeton at Plainsboro, N.J.

For 10 weeks, Grant shadowed the project manager, observing his role in the construction of a LEED certified building. (LEED is an acronym for Leadership in Energy and Environmental Design. LEED buildings meet certain energy-saving and sustainability criteria.)

“I worked in a site trailer, day in, day out, with the top people on the project. I learned about the intricacies involved in constructing a building. I also learned how to work with people. There are a lot of people on a construction site, and you have to function as part of a team,” says Grant.

“I enjoyed what I did. My internship reaffirmed that I am on the right career path.”
Neereja Sundaresan will not say physics is easy, but she does think it’s fun. “I’m not interested in throw-the-rock-off-of-the-cliff type of physics. I want to apply physics and build devices,” says Sundaresan, a senior in electrical and computer engineering.

Sundaresan, who has strong interests in math, robotics and computers, took the “Introduction to Electrical and Computer Engineering” course during her first year at Carnegie Mellon (CMU). She discovered electrical and computer engineering would allow her to use her head and hands to explore areas of engineering that excite her. She worked hard in her classes and it paid off. After her sophomore year, she became a research intern at Princeton University through a National Science Foundation program called “Research Experiences for Undergraduates.” There, in a “cleanroom” she created quantum bits. These are the smallest units of information in a quantum computer. She had to wear white coveralls, called bunny suits (no kidding), over her clothes. Afterward, she studied her nano-sized creations with a scanning electron microscope.

Sundaresan confides that when she started college, she didn’t know what “quantum” meant, but after two years in the College of Engineering, she had learned enough to engage in pioneering research. “If you want to get involved in research, you don’t have to know everything, but you have to have the interest,” she says.

After her first internship, she sought opportunities to work alongside CMU engineering faculty on their research. “Every time I go into a lab, I try to think outside of the box to solve problems. In research, there are lots of failures, but I enjoy a challenge.” As part of the college’s undergraduate honors research program, she is on a team that’s developing more efficient and cheaper magnetic storage devices for use inside of computers.

While Sundaresan has the skills to build sophisticated high-tech devices, she knows how to have fun. For a student-run engineering festival, she and two other classmates built an “Embarrass-You-Awake-Inator.” With $200 and one week’s time, they devised a digital clock that provides great incentive to get out of bed. They hooked up a video camera to a laptop that serves as an alarm clock. When the alarm goes off, the camera starts taking pictures of you as you sleep. If you don’t wake up and quickly get out of bed, the system will post those pictures onto Facebook. “The Embarrass-You-Awake-Inator is social media to the extreme. It’s hilarious,” says Sundaresan.
Meet Abigail Ondeck. She is studying chemical engineering at Carnegie Mellon University (CMU), and so is her younger brother Nathaniel and sister Mariah. All of them were exploring biomedical options too, until Abigail, a senior, decided she wanted “to work in energy.”

Ondeck’s career path veered from her siblings’ when she took a course called “Chemical Process Systems Design.” “It changed my life,” she says. In this upper-level course, student teams designed systems for processing Marcellus shale gas, an abundant form of energy in Pennsylvania. “We had to take the extracted gasses from the ground and find an inexpensive method for separating the various gasses using different unit operations. The team then determined the best method of transport for the gasses to the Philadelphia and Pittsburgh areas,” explains Ondeck. Although the project was theoretical, it explored real-life scenarios. “Our team was successful because we met the technical specifications of the project and were profitable in 4.5 years.” It was important for the team to prove the economic feasibility of their plan because companies will not use new technologies if they can’t earn a profit. “You can’t ignore the profit/loss aspect of engineering technology,” says Ondeck.

“The class was challenging, yet fun at the same time. I love math and applying fundamentals from earlier classes to the process design class,” she says. She wants to apply process design to address problems in energy production. For example, "solar power panels are not as efficient as other fuels and are also expensive to produce. If engineers can create a production process that is less costly, more people will be able to afford and access this type of energy.”

Ondeck’s advanced classes are stimulating and demanding, so to unwind she spends time with her friends in Kappa Alpha Theta. “Greek life is a great way to do things outside of engineering,” she says. It enriches her social life and provides venues for philanthropy and community service. She serves on a scholarship committee because “I want to help inspire people to think about their future academically.” She encourages women to consider graduate education, and she, herself, intends to pursue a Ph.D in chemical engineering at the University of Texas at Austin.

Of course, Kappa Alpha Theta hosts formal dances and sisterhood events, but for Ondeck, “Booth is absolutely amazing.” What she is referring to is CMU’s annual Booth Competition that’s held during Spring Carnival. For this event, student groups compete to build the most impressive carnival booth. “We built a two story building that people walk through,” says Ondeck. “Working on a booth is enjoyable, and that’s what life is all about—discovering where your interests lie and doing those interests—that’s what makes you the most happy.”
When Gabbi Coloyan was in high school, she wanted to generate electricity with a revolving door. However, at this point in her academic career, she didn’t know how this could be done. So, she tucked the idea away and enrolled in Carnegie Mellon.

Flash forward five years, and Coloyan, a senior in mechanical engineering, has now seen her idea realized. In her capstone design course, she and three classmates created a mechanically powered hinge that opens doors for people with disabilities. “I thought if I could generate energy from a door and save it, it could be used to open the door in the future,” says Coloyan. The team created a device that contains a spring and sits atop a door. When the door is opened repeatedly, the spring compresses and stores energy. When a disabled person hits a button, the spring is released, and the door automatically opens. “This is simple, but it’s innovative,” she says.

Coloyan, who is never at a loss for ideas, serves as the president of Carnegie Mellon’s chapter of the American Society of Mechanical Engineers (ASME). The student organization holds career-centered events throughout the school year, including a research fair in which students can talk to mechanical engineering faculty to learn about research and opportunities for summer internships.

When Coloyan was a sophomore, she told her professors that she wanted to conduct research. Soon she found herself developing theoretical models that illustrate how heat is transferred in carbon nanotubes. These tiny cylinders made of carbon atoms possess unique electrical and thermal properties that engineers are exploring with great interest. Coloyan says her research could be used in heat shields that protect satellites from the harsh conditions of outer space or serve in energy conversion applications.

For her comprehensive work, she won a trip to the King Abdullah University of Science and Technology in Saudi Arabia, where she placed third in an international undergraduate research competition. She, along with 49 other international students, spent 10 days in Saudi Arabia presenting their projects, attending educational events and exploring the region. “It was a fantastic experience. It was a little intimidating, but I felt adequately prepared. I traveled into Jeddah, and saw camels. I went snorkeling in a coral reef in the Red Sea. I got to see things that most Americans can only imagine,” says Coloyan.
Gabriella Oloyan

Mechanical Engineering
ANNETT

ASSOCIATE DEAN AND
PROFESSOR OF CHEMICAL ENGINEERING
After Annette Jacobson graduated from Carnegie Mellon University (CMU) with a bachelor’s degree in chemical engineering, she landed a great position at PPG Industries in the glass division. There she worked with inorganic coating materials to develop new glass products. In addition to working in a lab, “I traveled to manufacturing plants and tested new products and processes that we were developing,” she says. She enjoyed the research aspects of her job and wanted to contribute more, so she took evening courses at CMU working toward a master’s degree. Her co-workers encouraged her to pursue a Ph.D., which is research based at Carnegie Mellon. “At PPG, I was working in a research function, so a Ph.D. seemed like a good idea,” says Jacobson. She took a leave of absence from PPG to pursue a doctorate degree.

While she was working on her Ph.D., one of her professors asked her to give a guest lecture on her research. That lecture changed her life. “It was a great experience. It gave me a sense of what it is like to lecture in front of a class of students, and that sparked my interest in the possibility of a career in academia,” says Jacobson. As she delved into her graduate program, she thought about different careers. She worked in industrial research for six years and enjoyed it, yet she loved the idea of teaching as well. After obtaining her Ph.D. in 1988, she accepted a position at Carnegie Mellon as a lecturer. Today, Jacobson is a teaching professor of Chemical engineering and the director of the Colloids, Polymers and Surfaces Program. She is also the associate dean for Undergraduate Education in the College of Engineering.

Reflecting on how these events unfolded, she says, “I always had definite plans and goals. I learned as much as I could and kept my mind open to new opportunities. Since you cannot know what the future holds, you must be prepared for possibilities when they arise.”

Jacobson understands that many young women who enroll in college aren’t sure about what they want to study, and she doesn’t see that as a problem. While it is important to create goals and plans, she encourages students not to prescribe to any one plan too early. “When it comes to your career, you can’t predict all of the opportunities that will come your way. You will learn a lot about yourself, your interests and passions from the exploration process. You have to educate yourself first.” She advises students to “find something you enjoy doing, learn everything about it and excel at it. Once you have done this, you will be better equipped to make the decisions that are best for you.” This is the optimal way to make informed decisions about your career, recognizing, of course that your goals and plans may change as you do over time.

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Erica Spiritos hopes that if she ever settles into an office job, she can keep a bucket of Amazonian mud under her desk. However, until then, she is searching for opportunities that allow her to work outdoors and help communities across the globe with her engineering knowledge.

As a child, Spiritos traveled internationally with her family, and during high school she got involved in a community service project in Panama. When she arrived at Carnegie Mellon University (CMU) to pursue civil and environmental engineering, she already knew she wanted to be involved with an organization called Engineers Without Borders (EWB). However, there wasn’t an EWB branch at Carnegie Mellon, so she and her peers started one. Before long, they were in Ecuador, helping the Tingoans with water distribution.

Spiritos returned to Ecuador after graduating and led a community service trip for 21 high school students through a group called Road Less Traveled. They worked to build a school and help teach English to the community. Today Spiritos is interning in Israel, where she is doing engineering and policy work at the Arava Institute for Environmental Studies (AIES).

“AIES is a place where Israelis, Palestinians, Jordanians and Americans come together to build peace through joint initiatives addressing regional environmental issues,” she says. “I’m conducting an energy audit of Israel’s water policy to better understand the burden that the water sector places on the energy sector as a result of energy-intensive processes such as seawater desalination.”

Her experiences at Carnegie Mellon have helped her make productive use of the independence she has at AIES, where she steers her activities toward her interests.

“The possibilities to create or take part in exciting opportunities at CMU are endless if we take advantage of the spirit of entrepreneurism and innovation, and I am finding that the same applies to my work at AIES,” she says.

Spiritos explains that her global experiences have done much more than move her forward in her career. “Living in another country and learning to speak a foreign language exposes me to a larger world, to a whole new set of perspectives, to new cultures, to new ideas and systems of operation,” she says. “I think traveling gives us the opportunity to learn about the world, but also the chance to discover ourselves—our likes and dislikes, our values, our perspectives, our comfort levels and our ability to adapt to different situations.”
CIVIL AND ENVIRONMENTAL ENGINEERING ALUMNA
“REAL ENGINEERING PROBLEMS ARE DIFFERENT FROM TEXTBOOK EXAMPLES, AND AS AN ENGINEER YOU HAVE A RESPONSIBILITY TO WORK BETTER.”
Margaret Groves is an engineer who sells defense aircraft—fighter jets, tankers and cargo planes—to foreign allies. She is part of a sales team in the Global Technology R&D Strategy division at Boeing, a leading manufacturer of commercial jetliners and military aircraft. Groves’ role is to ensure that “we sell what we promise, but that we don’t give away any secrets.” Her deep technical knowledge protects our nation’s and her company’s interests in complex business transactions.

Groves began her career in a research and development (R&D) branch of Boeing called “Anti Chemical-Biological Warfare.” Her job was to protect human fighters from “anything that’s not a bullet,” she says. Threats, ranging from nerve gas to nuclear radiation, could stem from a direct weapons attack or arise from a malfunction or mishap on the jet.

Groves’ other early work involved certifying the flammability of commercial aircraft parts for the Federal Aviation Administration (FAA). Protecting aircraft from fire is a top engineering concern, and the FAA requires rigorous safety testing. Generally, aircraft parts are tested separately, and Groves was assigned to test computer motherboards, which are made of plastic, a serious fire hazard. Typically, individual components on a motherboard—the coating, the components and the board itself—were flame tested separately, which was expensive and time consuming. Groves and her team believed that it would be possible to test fully built motherboards and therefore certify entire groups of configurations at once, and still get accurate results. To investigate her idea, she built a range of motherboard configurations and attempted to set them on fire, using a Bunsen burner. Her theory proved right: testing all the components individually wasn’t necessary. This knowledge improved the testing process and saved millions of dollars every year. Her next major accomplishment was convincing “the FAA to trust us because we were confident with our test results,” says Groves.

Groves credits her education in chemical engineering and especially her engineering and public policy courses for teaching her that “real engineering problems are different from textbook examples, and as an engineer you have a responsibility to work better.” This outlook pushed Groves to tackle the motherboard problem.

Wanting to see more of Boeing, Groves ventured into sales engineering, where, “I get a bird’s-eye view of everything: technology, creating, buying and selling.” Her latest position as project manager has her traveling worldwide. “In my job, I have to overcome language and cultural barriers and that isn’t easy. Cultural backgrounds make a huge difference in how people perceive problems and approach solving them.” She encourages students to travel abroad so they can develop the skills they will need to work in global settings. “One of the reasons Boeing hired me for my current job is because I took my time and my own money to travel. College isn’t just about classes and getting a job. You have a life, too. Don’t be afraid to travel. It is an investment in your future.”
The College of Engineering at Carnegie Mellon University is internationally recognized for excellence in education and interdisciplinary research. At both the undergraduate and graduate levels, our flexible curricula allow students to customize their course of study to suit their interests and professional objectives. We prepare students for fulfilling and exciting careers.

**Majors the college offers include:**

- Biomedical Engineering*
- Chemical Engineering
- Civil and Environmental Engineering
- Electrical and Computer Engineering
- Engineering and Public Policy*
- Materials Science and Engineering
- Mechanical Engineering

To learn about the college, on the Web visit www.cit.cmu.edu.


For information about global opportunities visit www.cit.cmu.edu/global.

*Only available as a double major. Students must also declare another major in one of the five traditional departments.
National Society of Black Engineers (NSBE)
The NSBE mission is to increase the number of culturally responsible black engineers who excel academically, succeed professionally and positively affect the community. The Carnegie Mellon chapter participates in activities such as tutorial programs, group study sessions, community outreach programs, technical seminars and conferences.

Society of Hispanic Professional Engineers (SHPE)
SHPE strives to increase the number of Hispanic engineering and science students at Carnegie Mellon by developing programs with industry and the university. The activities are designed to increase career awareness, encourage networking with professionals, develop leadership skills and promote academic excellence.

Society of Women Engineers (SWE)
SWE offers scholarship, career, community service and social opportunities to its members. Some highlights of SWE’s programming and community service include their Technical Opportunities Conference (TOC), High and Middle School Days and Grad Greets. SWE members also participate in National Engineers Week, attend the National SWE Convention and build a booth for Spring Carnival.

Women in ECE (WinECE)
WinECE promotes professional development of women students and alumni in the Department of Electrical and Computer Engineering. The primary goal of WinECE is to assist its members in developing the knowledge, skills and attitudes that are necessary for success in their careers. This is achieved through mentoring, outreach, social events and activities.
DIVERSITY OF THINKING

We all grow up somewhere. It’s natural to be comfortable with people from similar backgrounds and even to shy away from people who are different. But that won’t prepare you for the job market. Engineers today work and live all over the globe, and they need to be comfortable in multicultural environments. You may be leading a team building an oil pipeline in United Arab Emirates or maybe creating biometric smart cards for use in Brazil.

An important part of real-world training involves living and studying in a culturally diverse environment. At Carnegie Mellon University (CMU) we acknowledge and respect the attributes each student brings to the university because of their specific background, culture and individual interests. A diverse student body deepens educational and cultural experiences and prepares engineering students for the technical and social demands of the workplace.

Teamwork, an essential component of engineering, is enriched by cultural variety. “You can contribute much more if you have a diverse team and attack a problem from many different perspectives,” points out Nadine Aubry, head of the Mechanical Engineering Department. The College of Engineering has a multinational population with more than 20% of our undergraduate students coming from outside of the U.S. from a wide range of countries, such as South Africa, Bulgaria and India. When CMU engineers enter the workforce, they appreciate differences and gain insight from people with different backgrounds. Our graduates enhance the quality of life by engineering solutions to society’s problems and by participating as citizens of local, national and international communities.

Carnegie Mellon has over 24 multicultural student organizations, including the National Society of Black Engineers, the Society of Women Engineers and the Society of Hispanic Engineers. These groups, along with many other student organizations, form a support system that contributes to a diverse and energized student body.