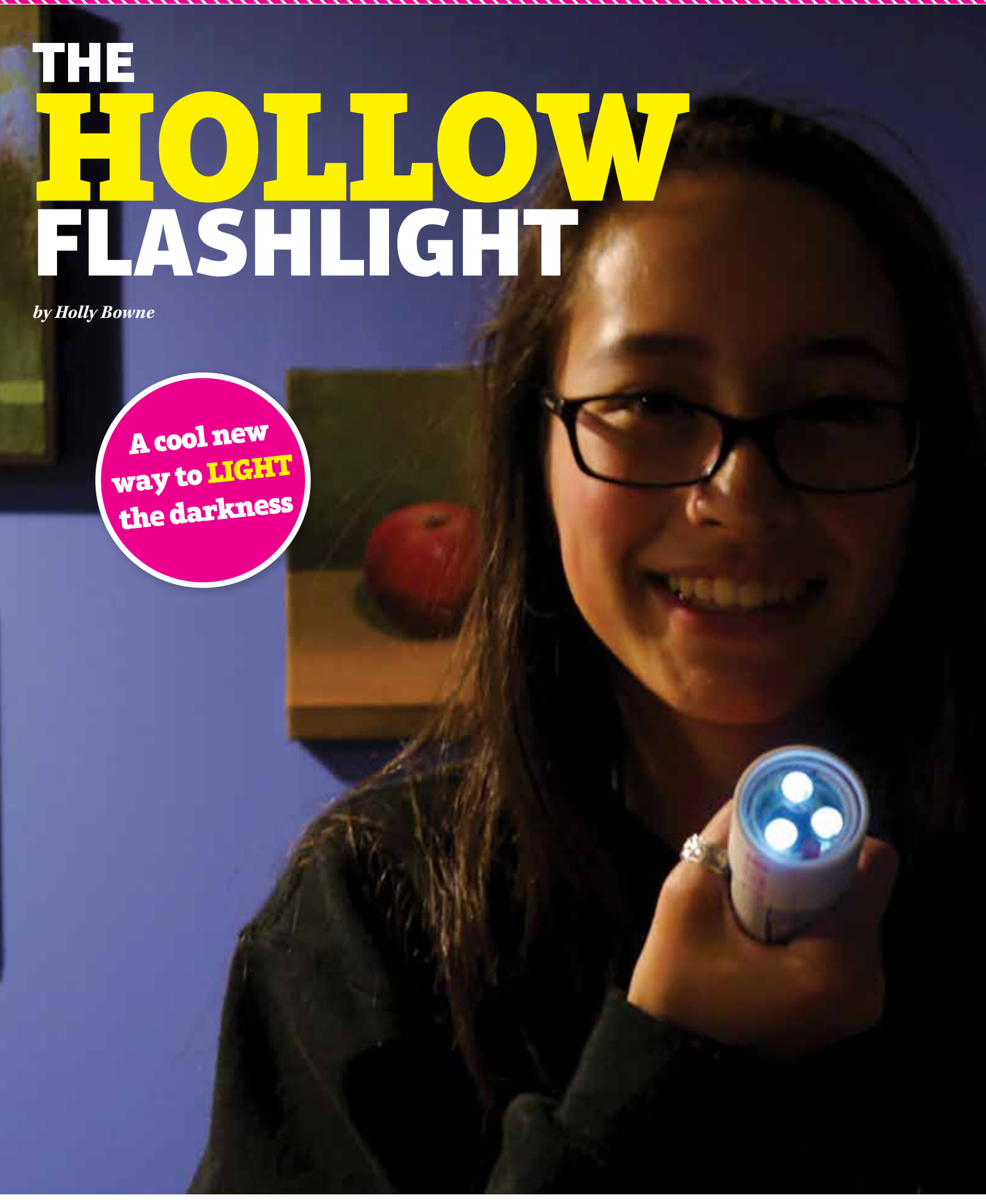
THE HOLLOW FLASHLIGHT

by Holly Bowne

A cool new way to LIGHT the darkness



Did you know that you have the power to light up a room right in the palm of your hand? Although harvesting human body heat to generate electricity sounds more like the plot of a sci-fi movie, Ann Makosinski from Victoria, British Columbia, made it a reality. At age 15, Ann invented a flashlight that uses no batteries. It doesn't rely on electricity, solar, or wind energy. The flashlight is powered only by the warmth of a human hand. And her invention could benefit 1.3 billion people—one-fifth of the world's population—who don't have regular access to electricity.

» BEGIN AT THE BEGINNING

Ann's parents support her interest in science and encouraged her to start entering projects in science fairs when she was 11. When Ann entered her flashlight invention in the Vancouver Island Regional Science Fair, she won second place. But one of her science teachers encouraged her to enter it in the worldwide 2013 Google Science Fair competition, and she won first place for her age category! Since then she's given three TEDx talks, was named one of *Time* magazine's 30 under 30 for 2013, and appeared

on the *Tonight Show Starring Jimmy Fallon*. "That was awesome!" she says.

Although Ann's invention has attained worldwide recognition, she admits she's not an all-A student. It's more important, she says, to "be curious about everything and ask questions." She also believes that when you have a problem, instead of looking for others to solve it, you should try to create the solution. "It might turn out to be someone else's problem as well," she says. "And you could end up helping a lot of people."

» INSPIRATION AND THE KEY

When Ann, who is half-Filipino, learned that a friend in the Philippines failed classes because she had no electricity and couldn't study at night, Ann was inspired to find a solution. While researching alternative energy forms, she learned that the human body is a great source of thermal energy (that's energy in the form of heat). In fact, the average human radiates enough energy to light a 100-watt light bulb. But how could she harvest that energy to actually power a light?

Ann learned about **thermoelectric** devices called Peltier tiles. They operate according to the "Seebeck effect": when one side of the tile is heated, and the opposite side is cooled, electricity is generated. She decided to create a flashlight using the tiles, with the palm of her hand heating one side and the **ambient air** cooling the other. She used a white LED, or light-emitting diode, to provide the light. Ann needed only 0.5 milliwatts of power to obtain sufficient LED brightness. Because the average palm generates about 5.7 milliwatts, she had enough power. But she soon discovered she didn't have enough voltage.

The Peltier tiles produced only about 50 to 70 millivolts. She needed 2,500 millivolts, or 2.5 volts, to light the LED. Ann spent months experimenting and researching ways to increase the voltage. She says she nearly gave up. But she eventually constructed a four-

WATTS WITH AMPS & VOLTS?

Electricity is the movement of negatively charged atomic particles called electrons. Some common terms used in describing electricity include: amps, volts, and watts.

Amps, or amperes, are units used to measure the rate electrons flow in a current. Volts measure the force of the moving electrons, or electrical flow. Watts is the amount of power produced, or electricity consumed.

To understand how these electrical concepts work together, let's pretend that electrical current is water flowing through a garden hose. The amps would measure how fast the water flows through the hose. The volts would be the water pressure; the higher the voltage, the faster the water would flow. And the watts would be a measure of how much water pours out of the hose over a specific period of time.

Mathematically, the relationship is described as: Watts = Amps × Volts.

Thermoelectric Producing electricity through temperature differences **Ambient air** The air in and around a building or device

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Annventions Blog:
http://annventions.com
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Ann (Andini) Makosinski
Twitter:
@annmakosinski

part circuit with a transformer that allowed her to achieve 5 volts.

PUTTING IT TOGETHER

To build the flashlight, Ann mounted four Peltier tiles on a hollow aluminum tube—which inspired the flashlight's name. She chose aluminum because it's a good heat conductor. She slipped the tube inside a larger PVC (polyvinyl chloride) pipe with a cutout opening around the tiles. She placed her circuit in the front, centered the LED in the middle of the tube, and wrapped the PVC pipe with insulating foam.

Ann carefully gripped the flashlight with her warm palm covering the exterior side of the Peltier tiles while the cooler ambient air flowed freely inside the hollow tube. The LED glowed brightly! When she tested it outside in 50-degree Fahrenheit weather, her flashlight maintained a steady beam for more than 20 minutes. Further experiments showed that in order to work, the flashlight required a nine-degree temperature difference between outside air and body heat.

ENDLESS ENERGY

What do a flying Frisbee, a roaring bonfire, and the cereal you ate for breakfast have in common? The kinetic energy of the Frisbee, thermal energy of the bonfire, and chemical energy of your digesting cereal all represent a transfer of energy. In physics, this is known as "work." Electric companies generate electricity by using transferred energy from fossil fuels or alternative energy sources. For example, when power plants burn oil, coal, or natural gas, that fuel becomes heat energy, which boils water to produce steam. The steam becomes kinetic energy, turning the turbine of an electrical generator. The generator spins wire coils in a magnetic field, transforming the kinetic energy into the electricity that's sent through the wires into your home. And while energy can change form, it can never be created or destroyed. So the energy we're using today has been around since the universe was created!

THE FUTURE IS BRIGHT

Ann is now in her senior year of high school. When she's not inventing things, she enjoys watching foreign and classic films and playing with Shadow, her lilac Burmese kitty. She's getting a patent for her flashlight design and has also developed a headlamp using Peltier tiles, with the ability to hold a charge, "but not in a battery!" she adds. She's already been contacted by companies interested in manufacturing her flashlight, so she's focusing on improving its brightness and efficiency. "I want to be able to distribute my flashlights to people who really need them," Ann says. She hopes to light the darkness for those, like her friend, living in developing countries without electricity.

Holly Bowne is a freelance writer living in White Lake, Michigan. She loves writing about the cool accomplishments of teens and tweens. She is most grateful for her desk light that lets her work on writing projects late into the night. Visit her at hollybowne.com.