

A woman with a green headband and a grey cardigan over a green shirt is holding a white air quality monitor. The monitor's screen shows a green bar and the number 50, with the text 'Slightly Elevated' below it. The background is a blurred outdoor setting with a red awning.

“The air gets weird and stinky in the summer. You hear about how asthma rates are through the roof around here.”

Judy McAuley, owner of Happy Baby Company, Bellevue

Judy McAuley sells Speck Sensors in her Happy Baby Company store and uses one in the shop as well. Happy Baby is near a coke works plant, so Ms. McAuley had no hesitation in having her store become the first brick-and-mortar business in the Pittsburgh region to sell the air quality monitors.

AIR measures

A portable air quality monitor developed at Carnegie Mellon University is growing in popularity locally. But the Speck Sensor also is attracting national and international attention, pushing demand higher.
By Megha Satyanarayana

As Judy McAuley chats with customers at her baby supply store, a small white box on the counter flashes numbers on its digital display: 20, 19, 21. The customers at Happy Baby Company stop to look before paying for natural teething necklaces, cloth diapers and BPA-free baby bottles.

The box is an air quality monitor called the Speck Sensor, and it's telling Ms. McAuley that the air inside the store is relatively low in a specific and dangerous type of pollution. This is important to her because, like many businesses along Lincoln Avenue in Bellevue, a borough northwest of Pittsburgh, Happy Baby is next to the Shenango coke works.

"The air gets weird and stinky in the summer," said Ms. McAuley, who lives nearby. "You hear about how asthma rates are through the roof around here."

Southwestern Pennsylvania's air quality ranks among the worst in the nation, and 60 percent of Allegheny County's fine particle pollution comes from industrial sources. So, it was a no-brainer that Happy Baby should become the first brick-and-mortar business in the Pittsburgh area to sell Specks, Ms. McAuley said.

"Air quality is important to me," she explained. "Especially living where we do."

Speck Sensors are the work of Carnegie Mellon University robotics professor Illah Nourbakhsh and his team at CMU's CREATE Lab. After he talked with The Heinz Endowments in 2011 about using technology to empower people, the foundation granted Nourbakhsh about \$200,000 to prototype and test the portable indoor air quality meter.

The goal was to help people visualize the invisible, said Dr. Nourbakhsh. "What surprised me was the degree to which people feel unempowered about air."

Interest in Speck Sensors has increased so rapidly that, since the prototype was created late last year, orders have come in not only from across the Pittsburgh region, but also from places as far away as Singapore. To meet current demand, 3,000 of the monitors are expected to be produced by year end.

The Specks measure fine particulate matter that is 2.5 microns or less (PM_{2.5}). These small particles, whether metallic, organic or a non-metal inorganic, enter the nose and get lodged in the lungs, making them hard to cough or sneeze out. From the lungs, PM_{2.5} enters the bloodstream, where it has been linked to everything from autism to asthma, obesity, reproductive issues and even premature death.



The monitor consists of a circuit board, fan and infrared sensor, among other parts. The fan creates a vacuum, drawing air past the infrared sensor. As particles pass the sensor and disrupt the beam, the chip captures each disruption, and converts those disruptions into readings that correspond roughly to the U.S. Environmental Protection Agency index for air quality. For many users, the Speck is their first glimpse at indoor air quality.

Users can sync their Specks with their computers to gather data throughout the day. The data is private, said CREATE Lab Project Director Beatrice Dias, and from it, people can start to see what in their environment may be impacting their air quality. For example, someone may be cooking without adequate ventilation when the meter spikes, she explained. Cars may be idling outside. Or, for Happy Baby, the coke works might be active.

Mobile apps also are available for Speck Sensors. In addition to helping track and visualize data, the app allows users to compare air quality across several different cities simultaneously.

But Specks have limitations. They measure PM_{2.5}, but not the entire range, so values are approximate. The sensors can't tell us what's causing high readings—maybe it's diesel exhaust from cars or increased black carbon in the air from nearby industry. And Specks only measure one kind of air pollution—indoor air could be rife with other contaminants.

For this reason, Specks are a snapshot of air quality; the data isn't enough to fight regulatory battles with polluters. At Happy Baby, Ms. McAuley said, the numbers stay pretty low when she has the shop door closed, meaning her indoor air quality is low in fine particulates, but the numbers jump up when the door stays open.

From prototype to mass production took a lot of teamwork. At first, two lab members built Specks by hand, one assembling circuit boards and another installing fans and the sensors, taking about a day to make a single monitor. When the CREATE Lab team had a prototype ready last year, about 70 were used in pilot testing. Word spread, said Dr. Dias, and soon, the lab was overwhelmed.

In the Speck Sensors' early development, two members of Carnegie Mellon University's CREATE Lab built them by hand. Today, the monitors are mass produced at EPD Electronics, left, a company northeast of Pittsburgh.

“We couldn't produce enough to meet the demand and the needs in the community,” Dr. Dias noted.

Last spring, as demand for Specks outpaced the team's ability to put them together, Dr. Nourbakhsh spun the technology into a company called Airviz and contracted with a local firm,

EPD Electronics, to manufacture the machines. Soon after, at the South By Southwest music, film and technology festival in Austin, Dr. Nourbakhsh introduced Airviz and the Speck to the masses.

Immediately, Infosys, a well-known Indian information technology company, announced a \$2 million investment in Airviz. As orders stream in, the CREATE Lab team hopes to find other brick-and-mortar businesses to stock them. And in a nod to increasing interest in air quality, other labs at CMU are also developing sensors.

In the meantime, users can check out Specks at 14 Carnegie Library of Pittsburgh locations, Dr. Dias said. The monitors also are being used at the Propel Hazelwood charter school as a teaching tool and in shale gas areas to help residents monitor their air.

“People really care about the air,” Dr. Nourbakhsh said. “We are not designing a tool that people don't need.” **h**

out there

Specks are primarily for indoor use, but they also can measure outdoor air quality. Our magazine staff took one monitor to (or held it across from) various well-known local landmarks: The Doughboy World War I memorial; Roberto Clemente Bridge; PNC Park; Phipps Conservatory and Botanical Gardens; Phantom's Revenge steel roller coaster at Kennywood amusement park; and North Park Lake, a popular location in Pittsburgh's northern suburbs. The Speck recorded levels ranging from a moderate 25 to an elevated 81, with some readings affected by changes in vehicle traffic—or kayak paddling.



Doughboy statue
Lawrenceville



Phantom's Revenge
West Mifflin
(from Kennywood Boulevard)



Clemente Bridge
Downtown/North Shore
(from Allegheny riverbank)



North Park Lake
Pittsburgh



PNC Park
North Shore
(from Clemente Bridge)



Phipps Conservatory
Oakland