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Hot on the trail of cold facts

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From left, Calder Brown, 14, of Providence; Markus Stein, 12, of Barrington; Andrew Wallace, 12, of North Providence, at rear; Harry Johnson, 13, of Warwick; and Alex Stein, 13, of Barrington, collect the final data from the laptop.

The Providence Journal / Kris Craig

PROVIDENCE -- How much energy a building uses during winter may depend not only on how cold it is outside, but also on which direction the wind is blowing.

That is one of the initial findings of a group of middle-school-aged students who have been studying the energy use of an old building -- the Providence Children's Museum -- for several months.

They found that even a slight shift in wind direction will change how much energy is needed to heat the building. When the wind blows from the southwest, it costs the museum \$6 to \$10 a day

more than it does when the wind comes from the west, said Harry Johnson, 13, of Warwick.

He and the other students are members of Engineers of Tomorrow, a team of mostly home-schooled youths who won -- for the second year in a row -- the statewide Lego League Robotics Competition. The team of eight students range in age from 12 to 14.

The contest, which took place at Roger Williams University in Bristol in January, involved building a robot out of Lego pieces, wheels and motors. The brain of the contraption is a small, onboard computer that resembles an MP3 player. The students wrote programs to instruct the robot to perform certain pre-defined tasks, and they were awarded points depending on how well the robot does.

Since the Engineers of Tomorrow won the state contest, they'll represent Rhode Island at the league's World Festival in Atlanta, April 17 to 19.

But the competition isn't just about robotics. The students also had to complete a research project -- an energy audit of a building. The Engineers of Tomorrow chose the Providence Children's Museum.

The ambitious project included compiling the museum's electricity and gas bills, studying the 82-year-old building's design, interviewing museum staff members about how power is used, and researching techniques for improving energy efficiency.

The museum was a perfect choice for the energy audit, said Matthew R. Stein, assistant professor of engineering at Roger Williams University, and the team's technical mentor. The team includes Stein's sons Markus, 12, and Alex, 13, of Barrington Middle School.

The museum's mission, Stein said, is to communicate information to the public, so the administrators went out of their way to dig out old power bills, and give the students access to the basement where the gas meter is located. And the museum is the kind of place where children like to hang out.

The museum staff welcomed the team.

"I was absolutely charmed," said Janice O'Donnell, the museum's executive director. "These kids are so smart and so earnest. Of course, we're all about kids, so were very happy to help."

Although the museum gave the students some past energy bills, the team wanted to know how much energy was used each day. So in January, they rigged up a camera to automatically photograph the museum's gas meter to get more-detailed data.

The camera was connected to a laptop computer in the basement and aimed at the gas meter to take pictures of the gauge, which looked like a car's odometer. Johnson wrote a computer program that instructed the camera to take a picture every three hours.

But there were problems. At night, the museum's lights are turned off, so the camera didn't work during the nighttime hours. The students plugged in a lamp, but that sometimes got turned off by museum staff members who didn't realize what the light was for. Finally, the students found a tiny light, powered by the laptop computer, to illuminate the meter. They photographed the meter's gauge through a mirror because the light took up a lot of space.

Every few days, Stein, or Mary Johnson, the team's coach and Harry's mother, would bring one or

more of the team members to the museum to grab the electronic images. At their Tuesday meetings, team members would run a program to reverse the backward images and to enter the numbers in a spreadsheet.

They also gathered daily weather conditions -- temperature, wind speed and direction -- from the National Weather Service Web site, and entered that information into a spreadsheet. For the past two weeks, the students have been trying to find how the museum's gas usage changes with the weather. They finished their analysis last Tuesday.

"One of the most interesting correlations we found was the relationship between the wind speed and natural gas usage," Harry said. "When the wind intensifies, the natural-gas usage increases, and when the wind dies down, the usage decreases."

The team narrowed down what they believed to be the biggest energy wasters: the museum's windows.

Windows cover 21 percent of the building's surface, Harry said. "If the Providence Children's Museum had replaced all of their windows with more energy-efficient double-paned windows with argon gas filling and low-E coating on both sides [which have an R value of 3.5], they would have saved \$552 over the course of our 50-day study."

"Also, the 8,780-square-foot roof is uninsulated, so a great deal of heat is escaping through there."

O'Donnell, the museum's executive director, said the team's study confirmed their decision to replace the old, leaky windows. The museum has begun its bid process to see how much it will cost to replace the 80 exterior windows. She said she'll pass along the bid information to the students for some more analysis. "They're figuring out how long it will take to recoup our investment, which is very helpful."

The students said the experience has taught them to think about using energy more efficiently.

"I'd never thought about it before this year at all," said Calder Brown, 14, of Providence. "I'm actually starting to realize how much energy we're losing through windows and other ways heat escapes the house."

He said he has always been told to turn off the lights in an empty room, but it didn't really sink in until he worked on the energy audit project. Now he turns off his computer rather than let it run all night.

The members of the Engineers of Tomorrow include four other students, all home-schooled: Andrew Wallace, 12, of North Providence; Kyle Inman, 13, and his brother Shane, 12, both of Glocester; and Julia Smith, 12, of Cranston.

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