APPLICATION NOTE

Running on sunshine

Engineering students build solar-powered race cars from scratch

Engineering students at the University of Kentucky win the inaugural Fluke Connect® Student Contest with their solar car optimization project.

It's a compelling vision: A solar-powered family sedan zooms down the interstate. Photovoltaic cells on the roof capture the sun's rays and power the car's motor and charge its batteries, resulting in virtually limitless range. Forget mpg and emissions. Yet, numerous technical and physical hurdles–including sunset and weather issues like cloud cover—still make such a dream largely science fiction. But that hasn't stopped anyone from trying to make solar dreams real.

The design, engineering and building of fast, efficient solar-powered race cars has been the mission and passion of engineering students the world over for the past couple of decades.

Among the top competitions are the World Solar Challenge, a race across the Australian continent, the America Solar Challenge, a cross country endurance race generally held every two years in the United States, and The Formula Sun Grand Prix, an annual track event, which took place in Austin, Texas, this past summer from July 26 to July 31. A number of high school teams compete in the Solar Car Challenge in Texas.

One team of aspiring engineers designing, building and racing solar cars are members of the University of Kentucky Solar Car Team.

Students run the show

The team is fully student run and managed and involves students in schools of study from a broad spectrum, including all the engineering fields as well as social science.

"Everything from the management to the engineering to the fabricating and design are all done by students," said Joshua Morgan, a junior studying electrical engineering who is the electrical team leader for the solar car.

"Our team encompasses all the fields of engineering at UK–chemical, civil, electrical, and mechanical, and all work in a different capacity," he said. "We also have business majors, media majors and fine arts majors on the team."

In addition to the practical work experience with the hardware and software, the solar car team provides an outreach to younger students involved in Science, Technology and Engineering and Math (STEM) programs. They visit elementary and middle schools to show off the car, talk about the project and generate interest in STEM.

"The visits show them some of what they can do in college," one team member said.

New car every 3 years

The team builds an entire new car every three years. That enables each group of aspiring engineers to gain experience creating a car from the ground up–from designing and fabricating, to installation electrical and mechanical systems to refinement and racing.

Much of the development, and the most visible and exhilarating, involves drive time, either on a parking lot at the Lexington campus or wheeling down the streets down town or out on the backroads of Kentucky.

According to Morgan the car can run about three hours off of batteries only and another six to eight hours if there is sun. One of the biggest barriers solar cars face for wide adoption, he said, is the amount of surface area required to be dedicated to the solar cells. Thus, it may be more feasible for battery powered electric cars to be charged by larger solar arrays on rooftops of residential homes rather than have the solar cell atop cars. Some solar charging stations are even currently being developed in California. Still, the solar car remains an incredible learning project and advances are made every year in the various systems that make up the car.

While gearing up for the Formula Sun Grand Prix, the University of Kentucky team won the inaugural Fluke Connect Student Contest. A panel of judges determined the UK solar racer crew best demonstrated how using Fluke tools improved their project and mad sharing those findings easier.

Fluke Connect contest winners

The team collected their championship prize with a paid trip to the Seattle area and Fluke headquarters where they met with executives, engineers and even the team of engineers and product designers that developed the hardware and software they used in their winning entry.

Chris Heintz serves as the solar car team's mechanical leader.

"It was great to see and meet with the whole Fluke Connect team," said Heintz, "and see what we did with (Fluke Connect) aligned with what they imagined we would do with it."

The Fluke Connect contest aims to test the skills, innovation and a business application of students enrolled in colleges, universities, technical schools and apprentice programs. It's also a

chance to learn the capabilities of Fluke Connect, a relatively new wireless test and measurement system that includes Bluetooth- or Wifi-enabled tools, a phone app, a web interface and a cloud-based storage system.

The students obtain practical experience using connected meters and an infrared camera. The tools enable them to automatically capture measurement data and share it with their peers. And their feedback on their experiences will help Fluke develop and improve the growing Fluke Connect system.

The winners of the Fluke Connect Student Contest were determined by which team made the biggest impact using the Fluke Connect system—with 75 percent of the decision based on evaluation by six industry judges and 25 percent on the public vote on Facebook. The University of Kentucky Solar Car Team was among four finalists.

Part of their submission was a video posted on YouTube in which the students highlighted their objectives, methods and successes.

Five of the principal team members—students Morgan, Daniel Cambron, John Broadbent, Zach Reeder and Heintz, along with advisor Matthew Morgan, made the visit to Fluke Park, north of Seattle. Besides a meeting with Fluke leaders and tour of the plant, the group also toured the nearby Boeing plant as well as the Future of Flight Aviation Center next door.

Increasing energy efficiency

The Kentucky team's prize-winning application was a project designed to increase the energy efficiency of their solar car—dubbed "Gato del Sol" in homage to the school's Wildcat mascot. To optimize efficiency, the team designed and conducted live performance testing using wireless Fluke meters and the Fluke Connect App performed troubleshooting with an infrared camera.

The Fluke system helped them realize a 16 percent decrease in idle energy consumption and a 5.5 percent increase in dynamic energy efficiency.

"Because all the energy we use actually comes from our solar cell array, we have to be really careful about how we use that energy. We want to be very efficient so that we can drive farther and not waste the energy," Josh Morgan, the Fluke Connect project lead, said.

So in an effort to meet the efficiency goal the students captured live data from a Fluke 3000FC digital multimeter connected to their solar car. At the same time students in a "chase car" recorded and shared voltage and current measurements over the phone with the Fluke Connect app.

“Being able to watch the data real time while we were driving in downtown Lexington was critical to help us better understand the car and drive it more effectively,” Morgan said.

That helped them find a more efficient cruising speed for the car.

The Fluke Connect kit sent to the students, which the school will get to keep along with another $1,000 worth of tools, also gave many of the students their first look at an infrared camera and the potential for thermal imaging technology.

Infrared camera spots trouble

The students also took infrared images inside the car’s battery box and were able to quickly identify bad electrical connections that were emitting heat rather than providing more energy to the car–an inefficiency that team members said would have taken them hours to identify without the Fluke Ti95 Infrared Camera.

“One of the most important things we found with (the camera) were relay problems,” Heintz said. “We had some very inefficient relays that were lighting up on the thermal camera, and we were able to find a circuit to replace those with much more efficient relays.”

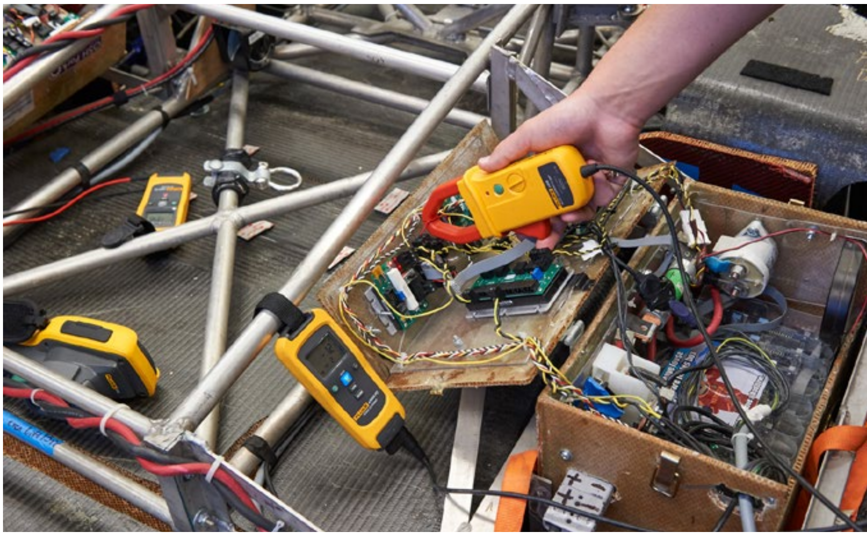
The infrared camera was also used to find hot spots on the brake pads, which it was determined had rubbing issues that contributed to increased rolling resistance.

The Fluke Connect app allowed them to share those images and measurements with their large team scattered throughout campus with various schedules.

“We could all push our data to the Fluke server and we could look at it at our leisure,” Heintz said.

But according to the team members, the most surprising capability of the Connect system was how the Bluetooth radio was able to penetrate through a solid concrete ceiling above the garage where they keep their solar car. Typically a student had to stay in the garage with a meter to monitor battery charging in order to make sure the batteries would overcharge and create a fire hazard.

“Using Fluke Connect we were able to look at the data on our cell phone while in our office on the second floor through the concrete floor,” Morgan said. “That saved us a lot of time because we were able to multitask and work on other projects while we were charging the car.”



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