Circuit Training: Electrical Engineering at CTY

by Alex Goodisman

When I was in elementary school, I really liked LEGOs. I kept stacks of LEGO instruction booklets in my room next to an enormous tub full of bricks. Periodically, I would take one of the booklets off the top, dismantle my latest project, and start working anew. When I was in third grade, my parents decided to take the next logical step and buy me a circuit kit. It followed the same basic principle: put the pieces together according to the instructions. But this time, instead of making static LEGO models, I was making functional circuits. I built everything in the instruction booklet, from a simple light switch to a working radio. My father found more instructions online, and I built everything there as well, including a miniature alarm system and a multi-speed fan.

The whole time, however, a question persistently bothered me. Anyone can follow instructions, but where do the instructions come from? When I tried to design my own projects, I was quickly overwhelmed. I realized I didn't understand what any of the pieces actually did, and therefore I didn't know how to put them together to make a functional design. I graduated middle school with the question unanswered. In fact, it wasn't until the end of my sophomore year of high school that my thoughts turned back to my circuit kit. I had taken several CTY courses during middle and high school, among them Psychology, Biology, and Computer Science. When it was time to choose my next course, I decided I would spend my final CTY session finding an answer to my question. I registered for CTY's Electrical Engineering course, to be held at Skidmore College in Saratoga Springs, New York.

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Problem Sets and Soldering Irons

The first week of the course was essentially a general physics overview covering such topics as force, energy, and momentum, as well as an explanation of electric fields and circuitry. We spent most of this time doing problem sets (I didn't know it at the time, but that week alone would make my junior year introductory physics course infinitely easier!). Then, during the second week, we broke out the soldering irons. We alternated between learning the mathematical models used in circuit design, learning good design practices, and actually building our models.

We also conducted research on the history and future of electric technology and presented our findings to the class. My partner and I discussed a potential solution to the problem of excess capacity in the electrical grid. We learned that one idea being implemented in other countries is using surplus power to pump water uphill and then letting it flow downhill into a hydroelectric turbine during a shortage.

Jury-Rigging and Other Workarounds

"E.E." was not a difficult course. The concepts were easy to understand, the math was middle-school level, and the course did not require any prerequisite knowledge or skills. That said, it was not without its challenges. As with any engineering, there were unexpected problems, from a shortage of 1000-ohm resistors to exploding LEDs to someone mislabeling half of the timers. But part of what made E.E. fun was getting around these unexpected barriers: applying Ohm's Law to jury-rig a 1000-ohm resistor, limiting the current through the faulty LED so it wouldn't explode, and building a test circuit to sort the timers.

Building a successful project was almost as enjoyable as fixing a broken one. Each student designed and built a course-correcting mini-robot with bumpers on each side. Mine had electric motors for wheels and was wired with a photodetector to seek out light. Of course, the next logical step was to hold a contest to see whose robot could make it down the hallway first. I didn't win, but it was entertaining anyway, especially watching two of the robots collide and rebound.

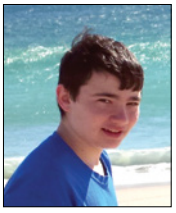
After the Solder Cools

CTY students often talk about their fond memories of the program and the friends they made through the classes they took. Much of the time, however, you don't hear about what they learned from the classes themselves. But E.E. succeeded in creating a memorable class experience for me. The classwork was legitimately fun and interesting. We frequently worked in groups and built projects together, and this helped me really get to know everyone else in the class. We stuck together at activities, at meals, and on breaks. E.E. was fun, social, exciting, enlightening, and new.

I entered the course with little actual knowledge about electricity and an urge to learn circuit design. By the end of the session, I was an expert with a soldering iron. I can apply Ohm's Law to circuit analysis, and I can tell you how a transistor works. After the solder cools and the batteries die, I think the biggest takeaway from E.E. is a basic understanding of "how it works."

I can't say, however, that E.E. completely answered my burning question. The course focused mainly on building circuits, not designing them. And my final project, the light-seeking robot? I built it from instructions. As a result, leaving CTY with my new soldering skills and my mini-robot, I was only slightly closer to my goal than I had been when I arrived. But armed with my new knowledge and a renewed interest in circuitry, I joined my high school's robotics team, where I was able to apply what I had learned to real problems.

For the final project in my introductory physics course, I built a model house with working lights and fans. For fun, though, I added an alarm and a backup power supply, and I'm working on a garage door. And for the first time, I designed my own circuits. ■



Alex Goodisman is a junior at Concord-Carlisle Regional High School in Concord, MA, where he helps run a creative writing club and environmental field studies group. He is a member of the fencing, debate, and robotics teams, as well as two a cappella groups. Alex enjoys playing piano and doing poi, a performance art in which tethered weights—in his case, glow sticks—are swung in rhythmic, geometric patterns.