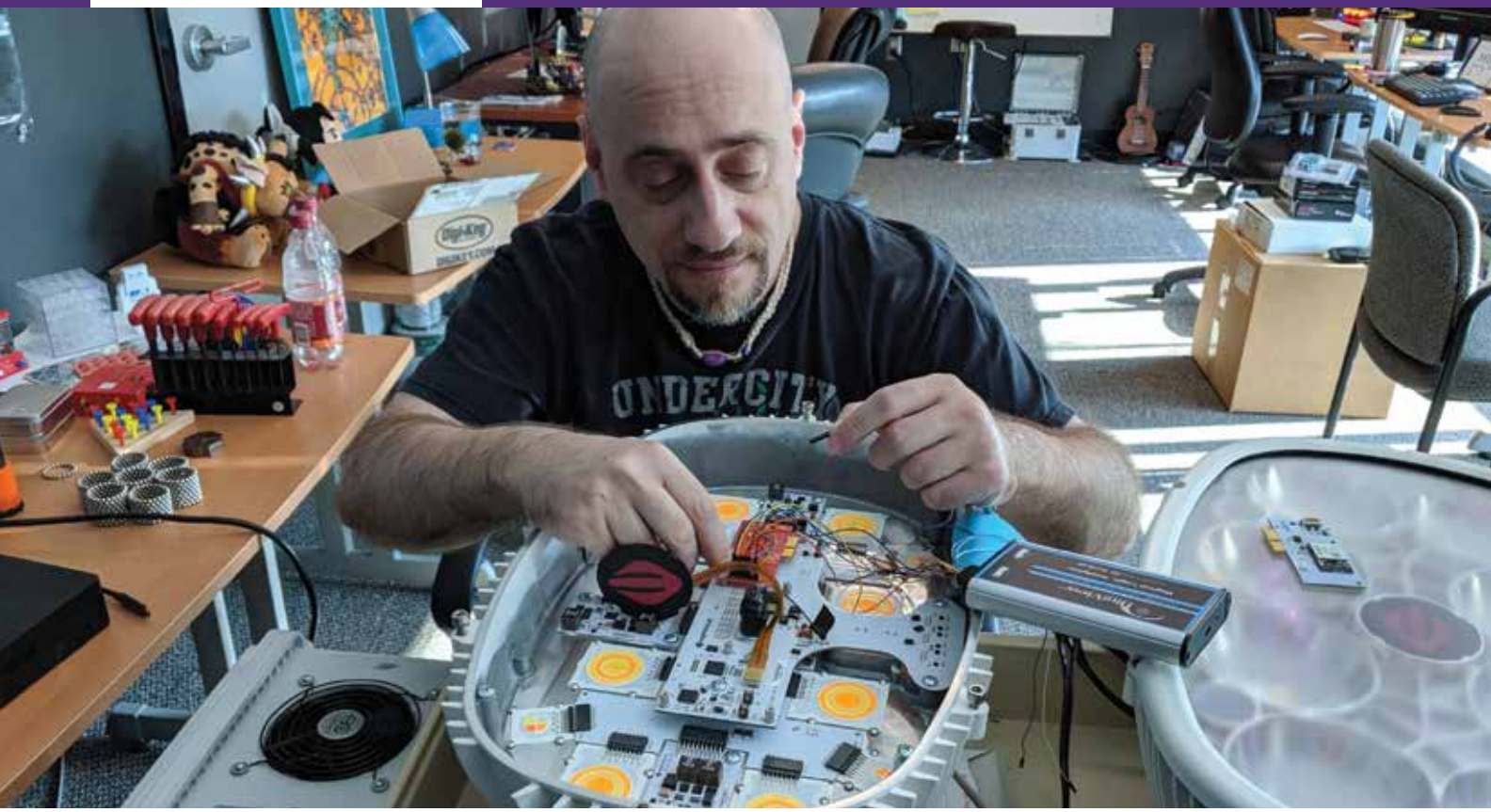


Design Engineer

BY LUBA VANGELOVA

Design engineers can work in many different fields, applying scientific and engineering principles to develop products. **Greg Luterman** works on embedded programming for Synapse Wireless in Huntsville, Alabama. Embedded programmers create software for a wide range of devices—from children's toys to heavy machinery—that "don't look like computers but contain a microprocessor," as Luterman puts it, to enable them to carry out their intended functions.

Greg Luterman connecting a logic analyzer to debug a stadium light. Photo courtesy Greg Luterman.

Work Description

These devices control real-world things, so my work often straddles the line between software and hardware. For example, I might write code that will trigger an action that drives a motor, or that will output a signal pattern to display the time, or that will decode a data sequence to receive a radio message. Embedded programming is a fun challenge because hardware engineers prefer to create designs with the cheapest CPUs possible, which often means working with slow clock speeds, little memory, and almost no code space.

The embedded code I'm currently working on goes into gigantic stadium lights. My programs allow operators to tweak the light's color so that the field looks good on television, to change the direction the beam is pointing, and even to flash the lights in fancy patterns when something exciting happens.

My days are fairly "interrupt driven." My boss keeps a list of tasks I need to work on (add feature X to controller Y, or fix bug Z), but because I bridge the divide between hardware and software, I get a lot of questions from both sides and often have to set my usual work aside to dig into other problems. It certainly keeps the day from getting boring and repetitive.

I really like setting up automated test systems. The most common problem programmers face is breaking one feature when they add another, because they test the new function, but not all the stuff that used to work before. Now each time we add a feature, we add an automated test that makes sure it works, and then if we break it later on, we find out immediately.

The most frustrating thing about my job is getting malfunctioning hardware made by other companies, and having to make extensive efforts to prove that it is their hardware, and not my software, that is malfunctioning.

Career Highlights

The trickiest bug I've ever found was an instance where one circuit board was writing to memory too quickly. Most of the data was written correctly, but some random bytes would get corrupted. It's very difficult and takes a lot of digging to find random, hard-to-repeat bugs like that.

Career Path

I always wanted to make new things. I loved electronics from an early age and tinkered with a lot of experiments and wrote a lot of computer programs. After getting my degrees in electrical and computer engineering from the University of Missouri, I did circuit-board design for different start-up companies for many years, working on speech-recognition software, heart monitors, and computerized brakes for trains.

Working for small start-ups is exciting, and you get a chance to wear a lot of hats, but they can be pretty volatile—one of my employers was struggling financially, and another decided to relocate. I hated my third circuit-design job, so I quit, traveled for a few months, and then took a job doing chip design for desktop computers. That job was downsized when the recession hit in 2009.

I didn't want to move, and it was easier to find programming jobs that let me work remotely, so I decided to switch to embedded software. Every board I had made needed software to be either running on it or talking to it. Writing such code required an understanding of how the boards worked, which most programmers didn't have. I realized that I enjoyed writing the code even more than designing the boards themselves, because I could change code and re-run it without any delay or cost.

My first embedded-software job involved working on data radios, which are modules that customers can place in different products to allow them to communicate wirelessly. For example, you could put one in a racecar to collect performance data, and then use it to transmit the data back to a base station for the crew to monitor.

Knowledge, Skills and Training Needed

Having a basic understanding of electrical engineering helps immensely. A lot of my job involves attaching logic analyzers to circuits to capture the patterns that my code generates. Without being able to "see" what is going on and understanding what the patterns mean, it's nearly impossible to fix bugs in my code. From a theoretical background, I learned a lot from a discrete combinatorial analysis class, which explored combinations, permutations, probability, and puzzles. Overall though, my education felt more like a basic foundation, and my real learning has been on the job.

Advice for Students

Make up projects and experiments for yourself. Tinker and create. You always learn more when you want to figure something out, rather than when you're expected to learn something. Also, home projects are always more impressive to prospective employers than anything you accomplished in school.

The easiest way to learn about embedded software is with a Raspberry Pi. Some of these computers cost as little as $5, and they are a great way to tinker and make interesting stuff. There are many websites devoted to what people have done with them, and how to do things with them yourself.

BONUS POINTS

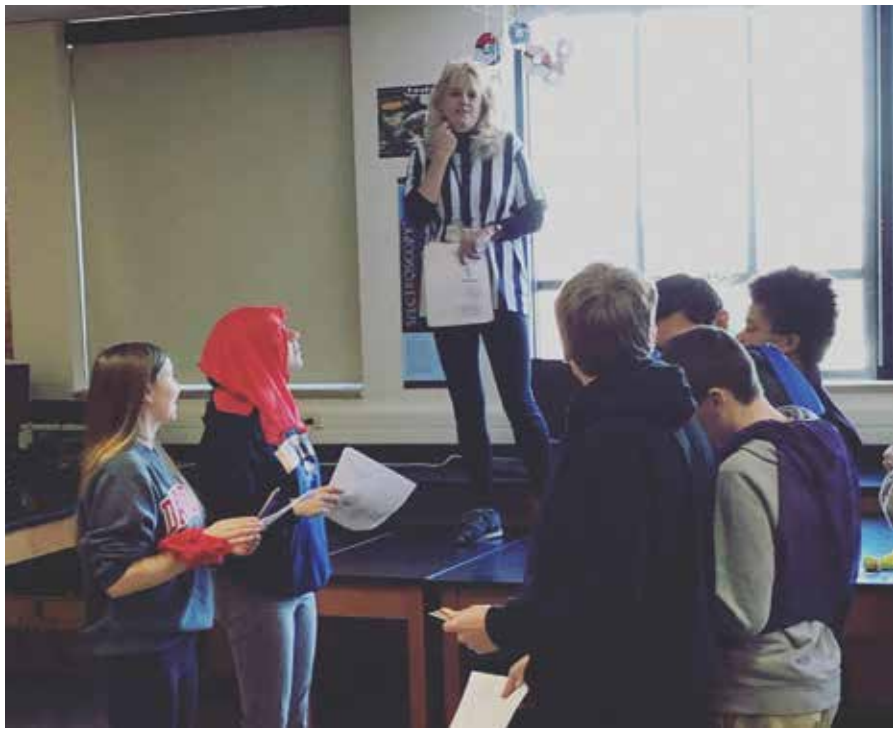
Luterman's Education: BS in electrical engineering and computer engineering, University of Missouri.

Web Site: *www.raspberrypi.org/*

Related Careers: Circuit designer, application programmer

Sandee Coats-Haan

Walnut Hills High School, Cincinnati, Ohio, Presidential Awardee in Secondary Science and a National Board Certified Teacher.



Students review for a final exam by working with partners in a football game simulation. Photos courtesy Sandee Coats-Ham.

Describe your pathway from being a chemical engineer to an award-winning physics teacher. How did the process impact your teaching career?

I've wanted to be a teacher since I was in second grade. But, there is little in our society encouraging students to become teachers. When I got to high school and loved chemistry and math, everyone encouraged me to be an engineer. The best school in Georgia was an engineering school (Go Jackets!), so I became an engineer.

I never lost the dream of being a teacher. I went on a business trip and read Tracy Kidder's *Among School Children*. I loved it. I kept looking for similar books. I even started reading educational methods books while still working as an engineer. Finally, one night while staring at the limited education book section in a local book store, my husband found me and said, "Why don't you become a teacher instead of just reading about them?" Without his encouragement, I'm not sure I would have made the leap to my life's purpose and passion.

Why did you decide to become Nationally Board certified as an Adolescent/Young Adult Science Teacher?

Teachers have lost respect in society. Becoming board certified is one way of demonstrating that there are complex skills and knowledge required for this profession.

I debated becoming recertified when I reached the end of my first certification. My state no longer offered any assistance with the application fee, nor was there any stipend associated with certification. At the time, I was working as a facilitator of online mentors for new teachers. Someone in that group suggested that you should never lose any certification that you have obtained. Based on that comment alone, I recertified. As it turned out, that certification was a factor that enabled me to get hired at my dream school and they DID pay a stipend. So, it was good advice.

Also to be perfectly honest, I am very competitive. If someone sets a bar, I want to jump it and board certification does this in a rigorous fashion.

Describe your school and classes.

If my students are reading this, they are thinking, "Oh, they should not have asked her that!" because I tell them daily that they are lucky to matriculate at "the number one school in Ohio, possibly the world." Technically, we are currently ranked #1 in the state of Ohio by *US News and World Report*. My niece who attends Phillips Exeter Academy might suggest that I am stretching the truth with the second part of my statement, but I love my school with its focus on academic excellence and the arts. For example, 17 students had perfect ACT scores last year and our theater program regularly wins CAPPIE awards, a Tony-like award for high school theater. But, what I truly love about my school is the ethnic diversity and the well-roundedness of my students. The same student who led her team to eighth place overall in a national engineering competition was also selected to perform a spoken word poem to introduce Dr. Mae Jemison, the NASA astronaut, when she visited our city. That's my school!

The down side to being in such a wonderful school is that we are extremely overcrowded. And, as part of an urban district, we fight for funds like any other urban school. We are, however, fortunate to have an alumni association that greatly supplements our programs.

I teach an unusual schedule. I only

have 3 classes, but I see each of those classes for two fifty-minute periods every other day, and a single period on alternating days. Currently, I teach AP Physics C as a first-year course and I teach AP Physics 1 and AP Physics 2, a two-year course designed by the College Board in a single year. For anyone familiar with these courses, you know this is a grueling pace.

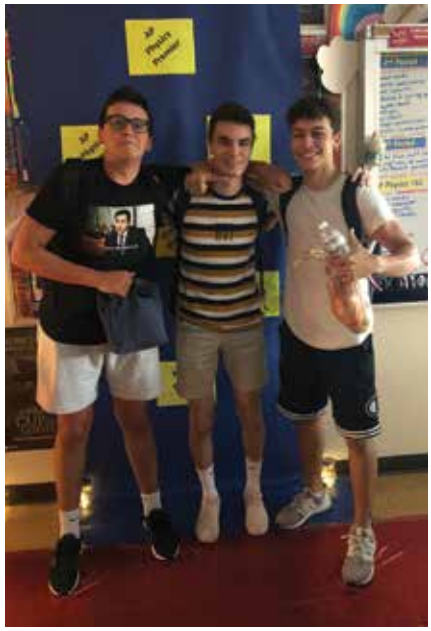
What are some of the resources you use for ideas and inspiration?

I'll start with the obvious: NSTA's *The Science Teacher*, AAPT's *The Physics Teacher*, NSTA press books, NSTA conferences, and College Board workshops. I'm still in contact with my science methods professor and just her very presence requires me to ask myself if I could do better. Right now, all the writings of Ron Clark and Kim Bearden, co-founders of the Ron Clark Academy in Atlanta, feed my teaching soul. Every teacher, administrator, and person involved in education funding should take at least a day to visit their magical school to see what education looks like when you have the most passionate educators and resource availability is not an issue.

I look for inspiration wherever I can find it, such as Instagram, the movies, the ball park. One of the things I've most enjoyed implementing in the past two years is breakout games. I learned about that resource from my Jazzercise instructor who teaches eighth-grade social studies. Even Jazzercise itself is inspiration; I have used it to demonstrate concepts about torque and rotational inertia.

Talk about your teaching methods. In what ways do you encourage innovative thinking in your classes? How do you keep everyone engaged?

I want my students thinking, thinking, thinking. The 5E learning cycle is the basis for creating my lessons. So, I try to provide them with hands-on experiences. If there is an equation they need, I try to have them derive it for themselves through a POGIL (process-oriented guided inquiry learning). I try to relate it to their lives. Resistors heat things up? What do you think is in that flat iron?



Arriving to physics class on the first day of school and being welcomed by a red carpet greeting and photo op.

I need to be excited about what I'm doing. For the first day of school, I used a red carpet, lighting, and music that my students encountered when they entered my room. There is even an AP Physics Premier backdrop for photo-ops just like a real movie premier. If I'm not excited about what I'm doing, how can I expect my kids to be?

You have to be willing to take risks. I wrote a digital breakout game for my students to review the ideal gas law before starting a thermodynamics unit. It was a hit and way better than watching a PowerPoint on something you already know. But, then I did the same thing to teach another class about cyclotrons and synchrotrons. It was a disaster. They did not retain any knowledge, despite the video clips and diagrams, because they were so focused on winning. I won't do that again!

What's the one project that you've always wanted to do but have never been able to, due to lack of time, money, etc?

I wish there was a time I could shut the "this could be a physics lesson" part of my brain down. This past summer, I was on a trip to an engineering competition with 16 students and a colleague. One night, we all stayed up late while the kids held a huge Smash Brothers tournament. My colleague immediately jumped in and started playing. I eventually did, too, and got DESTROYED, but first, I was watching the game and researching all the ways that I could use it on the first day of school as an example of physics in "real" life. So, there are a ton of ideas that are always circulating.

The idea that I am adamant that I will find a way to implement by next year is a cardboard regatta. I currently teach AP Physics 1 and AP Physics 2 in a single year to first-year students. I am working with the administration to eliminate that practice. I hope by next year to teach AP Physics 2 as a single-year course. The first unit will be fluid mechanics. The first project will be having students build a cardboard boat that they race across our school pool. PE classes are outdoors first quarter, so I am lucky to have access to the pool. If I am able to change the schedule, I will have enough time to do the project. All I need to do is find the money to purchase the cardboard and other construction supplies.

What do you feel is the most important big-picture takeaway for your students? If nothing else, what one thing do you want them to learn?

Obviously, I want every student to learn physics and ace their AP exams. But more importantly, I want them to love physics, science, and have an understanding of how our world works.

I want them to learn that I love them. No matter how they feel about physics at the end of the year, I want them to know that I was always on their side, rooting for the best possible outcome for them.

But, the most important lesson I want to give my students is that they can overcome any challenge. Physics can be a difficult subject. For many of my students, it is the first time they have ever had a class that was difficult for them. For some, it is the first time they ever fail a test. And those are the students I can really have an impact on. Together, we can figure out strategies that help them learn something that does not come naturally to them. Once they learn those skills, they can learn anything they set their mind to learn. What greater gift is there than that?

Describe a time a student impacted your life.

My students are my life. I am lucky to have lasting relationships with students who graduated more than 20 years ago. All of them have helped me in different ways—from the naval surgeon who I taught the year my son was born who mentally prepared me to be a military mom eighteen years later; the mechanical engineer who first demonstrated 3D printers to my students seven years ago; or the chemistry teacher who recommended me for my job at my current dream school.

But one student stands out. My first year at my current school was challenging. I was not like the previous physics teacher. One young man stood out as super grumpy. I remember overhearing him say about the valedictorian, "that should be me." I thought, "Wow, he's entitled." He slept a lot, no matter what my efforts were to engage him. It would have been easy to write him off as lazy, despite his excellent grades. One day, he came back after class looking for his wallet. It was just before lunch and when he didn't find it, I immediately offered to loan him a few dollars so he could eat. Did I mention he was a huge football player with a hearty appetite? He didn't miss a beat and responded, "Oh, no thanks. I get my lunch for free." I later learned that his part time job that came after football practice was his family's sole income. No wonder he was tired. No wonder he pondered what his class rank could have been without those extra responsibilities. Lesson learned: *Never ever assume you can look at a child and know where he or she comes from*.