Add Sizzle to Your Electronics Curriculum

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I. Introduction

This paper, of particular interest to the new educator in a two-year electronics program, presents innovative classroom and laboratory techniques which have proven to enhance student learning and interest. Technology students, often kinesthetic learners, may not learn easily from lectures but respond well to alternative methods and will listen if their interest is piqued by an element of fun or sizzle.

II. Improving Classroom Attitude

Since attitude in the classroom is crucial and contagious, new teachers from industry must "lighten up" and relax. The overall atmosphere is set primarily by the instructor. New educators coming directly from industry must quickly make the transition to a type of work that is very different and employs different methods of achieving the desired objectives. Students react best to a friendly setting with controls employed only as required to maintain class discipline. Without sacrificing quality and quantity of material covered, new instructors may need to slow the pace and demands on students, for they are not graduate engineers working full-time on an assigned project. On the other hand, educators with industry experience have a distinct advantage in the classroom when selecting objectives, for they can keep in mind how the student will actually use the information and skills in the workplace and should limit the material covered in the lecture/laboratory in light of what their industry work has shown to be important. Students are eager to hear " war stories " relating a topic or situation to the real world, and these can lead into educational objectives, and both interest and learning increase when relevant applications can be brought into the lecture. Students wonder, "Why do I have to learn this and how will I use this on the job?" Whether or not these questions are expressed, the instructor should show relevance whenever possible or explain that the concepts form a basis for future applications. At times, one may have to admit that the material does not have a direct application but explain that it teaches problem-solving skills: the ability to methodically analyze and reach a conclusion. Many new instructors fall victim to the tyranny of the textbook, believing they must race through and include every detail covered in the text, thus creating stress in the instructor which is telegraphed to the students. A better technique is to select those objectives that are most important and spend more effort creating a relaxed classroom in which students feel comfortable enough to interact with the material. I do not at all suggest that the instructor should be a clown, but humor, especially as it touches the student's personal interests or experiences, can be interspersed and used to make an academic point memorable.

III. Getting Their Attention

Although lecture is the most efficient way to cover new material, technology students often dread this part of the college experience and have a difficult time staying focused during the lecture portion of the course. Again, as educators, we must be diligent in searching for methods of creating interest. Using unconventional techniques can prepare the mindset of the class and improve the attention span. For example, when teaching the importance of ground fault interrupters (GFIs) in an industrial electronics course to my southern country boys, I illustrated with my own boyhood experience using 120 volts AC to “dig” for fishing worms. They were fascinated and begged me to tell them more. I warned them that I couldn’t discuss such an illegal and dangerous practice within the classroom but agreed to meet them outside under a clump of trees to continue the discussion. Although we didn’t actually “electrocute” any worms that day, I don’t think any of the students will forget the principles and applications of GFIs. And I have added this learning experience to each succeeding industrial electronics class.

Another technique that takes less time but works well to introduce a concept is using cartoons, which I display with an overhead projector. I am always on the lookout for relevant ones in the “educational section” of the newspaper. However, a good and easy source is a series available online from Agilent Technologies at http//:www.educatorscorner.com. Not only do cartoons gain attention, they often also provide a memorable visualization of a difficult concept. A blocking capacitor, for example, is illustrated by a mean-looking football player in a blocking stance, while units of inductance are illustrated by successively smaller Henries.

Perhaps my flashiest technique is best used at the beginning of a lab-safety discussion. I really want the students to pay close attention but recognize they are usually bored by such details as where the fire extinguisher and electrical breakers are located. Just before I get to the no-sound-effects-allowed-in-my-labs part of the discussion, I break my own rule by “inadvertently” touching an instrument while using magician’s flash paper to create a ball of fire. I picked up this technique from a magician at a family reunion. I am constantly watching for activities outside the classroom which may be adapted for use in the classroom. Your day–to-day experiences are rich with applications that can increase and reinforce concepts. . .once you become aware of their value.

Classroom incidents themselves can provide other techniques for the instructor who is watching for opportunities. While discussing voltage ratings on capacitors, a student asked if we could overvoltage one and watch what happened. The ensuing impromptu laboratory experience convinced me that every student in the class reacted strongly to exploding components. Thereafter, my basic electronics lab could look forward to destroying/exploding the “Component of the Week” each Monday. The students utilize a programmable power supply to set up the explosive conditions. To get different results, the students can program a step function for a quick explosion or a slowly varying ramp to slow-cook the component. The more smoke, the more enjoyable. Figure 1 below shows some fun with a transformer.

Figure 1: Exploding Components

Not only does this activity provide an opportunity to gain interest in component specifications, but it also provides an opportunity for the students to implement and value safety precautions, for they themselves set up the experiment and have complete ownership of this segment. While they are awake, I move quickly into the lesson of the day.

IV. Competing for Excellence

Of course, one of the values an electronics teacher wants to instill is cooperation, and we all provide many opportunities for teamwork. BUT, what they really love is competition both as individuals and as teams. I regard homework as very important for the student, but it counts as only a small part of their course grade. Consequently, a regular feature in my classroom is the "Homework of the Week," and it has led to a surprising increase in their diligence and attention to detail. Each week, I choose a homework paper that is particularly well done in regard to legibility, work shown, and completeness. I make a transparency of representative pages for projection on the screen at the beginning of class. I make a pretty big deal of the event with simulated drum rolls, etc. Following the ceremony, the transparency, marked at the top as "Homework of the Week," is given to the student to take home to show family and friends. As the semester progresses, the students begin to get creative with special color highlighting, sketches, and computer-generated schematics to try to claim the award. Most importantly, the general quality of the learning experience is greatly improved. This year I had a student who worked so hard and consistently, I instituted a "Homework of the Semester" award and presented her a certificate of achievement and a semiconductor data book

Another example of individual competition is the annual award ceremony where outstanding freshman and sophomore students are awarded certificates and book awards for lab and lecture performance. Originally set-up as an acknowledgement of achievement, these awards have become a motivational technique. The winners are also recognized in the campus newspaper and on our bulletin boards.

A third competition was developed to increase familiarity with and create interest in the use of the oscilloscope. First, the instructor misadjusts every control and covers the face of the signal source. Then, each student tries to unscramble the controls to get an image on a blank oscilloscope screen as quickly as possible and identify the characteristics of the signal. A small prize is awarded to the winning student.

Competition among teams also increases cooperation, adds interest, and (perhaps just as importantly) injects fun. Developing voltage from a grapefruit battery is an old standard for demonstrating simple battery operation and is always an enjoyable activity. But in my class it has evolved into a competition that pits each team against the others in trying to achieve the highest voltage. Excitement builds as each team tries different electrode placements, cleans the penny and nickel, and squeezes the fruit in a race against the clock. Again, small awards are presented to the winning team in a semiformal ceremony in front of the class. Since skill has little to do with the outcome, this activity frequently gives recognition to a weak team. On the other hand, the winner of the time-crunched circuit construction contest is often the strongest lab team. This activity is based upon a scenario set up by the instructor which can be as follows. The students are told they are at work, and the boss has just announced that a very important customer is coming to visit in two hours to see a demonstration of the circuit. It is crucial to the company that the circuit work properly and be documented by a short, written description of the operation. It becomes a race against the clock and the other teams to see who can get their circuitry constructed and have it free of mistakes. Amazingly, students rise to the occasion by working fast and accurately in an effort to win.

V. Making Real-life Applications

Since technology students are usually practical in orientation rather than theoretical, more likely to be tinkerers than dreamers, real-life applications make the theory more palatable. Early in the curriculum, we construct a kit in order to give the students the satisfaction and pride of creating an actual functional product. Building a kit teaches component identification, soldering skills, and mechanical assembly. We build an FM transmitter which allows the transmission of voice or recorded music through any FM radio, including their car radios. The student learns to operate the spectrum analyzer for trouble shooting and aligning the transmitter to the desired frequency.

Outdoor labs for our communications course include antenna construction and signal direction finding. Rather than listening to a lecture, students design antennas by applying radio frequency wavelength formulas; the teams then construct them, climb trees, hang wire, and record and plot standing-wave-ratio data. (See Figure 2.) Finally, using the amateur radio band, they transmit a signal on their antenna and study the radiation pattern. Students report that this is one of their favorite activities of the course because it is real.

Figure 2: Outdoor Communications Lab

Another real-life activity is a fox hunt. Students become “feds” for a day, hunting down an errant radio signal (transmitted by a student with a ham radio license) hidden on campus. This activity brings together real-life application, competition, and game playing. Needless to say, students work hard and enjoy the activity, as shown in Figure 3 below.

Figure 3: Students “Fox Hunt” with a Direction Finder

The Programmable Logic Controller (PLC) class synthesizes theory and programming applications to provide a plan for the automation of a local feed mill. Following adequate classroom training on sensors and the PLC relay ladder logic instruction set, the students go to a local mill, where they take notes on the current non-automated method of operation. The teams then prepare a plan for automating the process and a formal report describing their new design. It has been gratifying to see the level of effort and quality of work emerge from just average students when they are released to be creative. Figure 4 shows a portion of one student's proposed system.

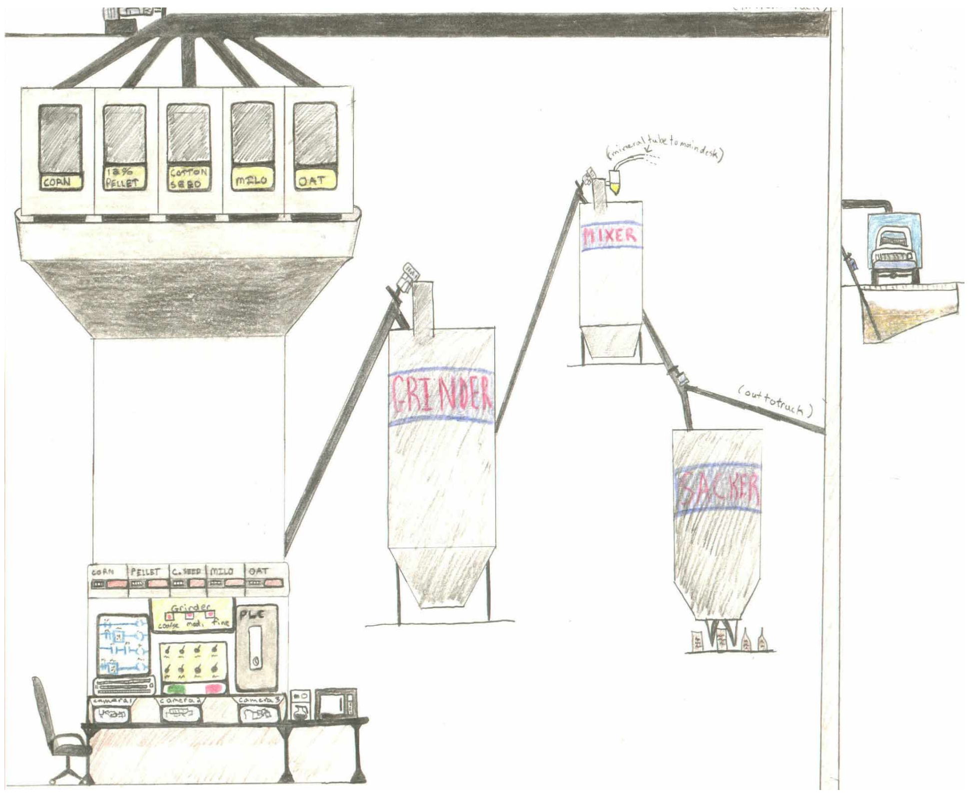

Figure 4: Excerpt from Student's Automation Plan

In addition to the big projects for real-life applications, the teacher can be constantly looking for ways to enhance the standard, laboratory-book experiments. In a digital electronics lab, for example, rather than using a signal generator to create clock pulses for a counter, I sometimes use photoelectric or proximity sensors like those used in manufacturing, so the student is able to see actual practical applications for the circuit. (See Figure 5.) Further, the student is able to practice his/her skills by wiring the sensor in either current source or sink configuration. Since many digital experiments use light-emitting diodes as indicators, I have found that students react positively to a change to other devices where appropriate. One example might be to drive a relay coil, which in turn activates a small dc motor. In general, student interest and attention increase whenever devices make a noise, rotate, or move.

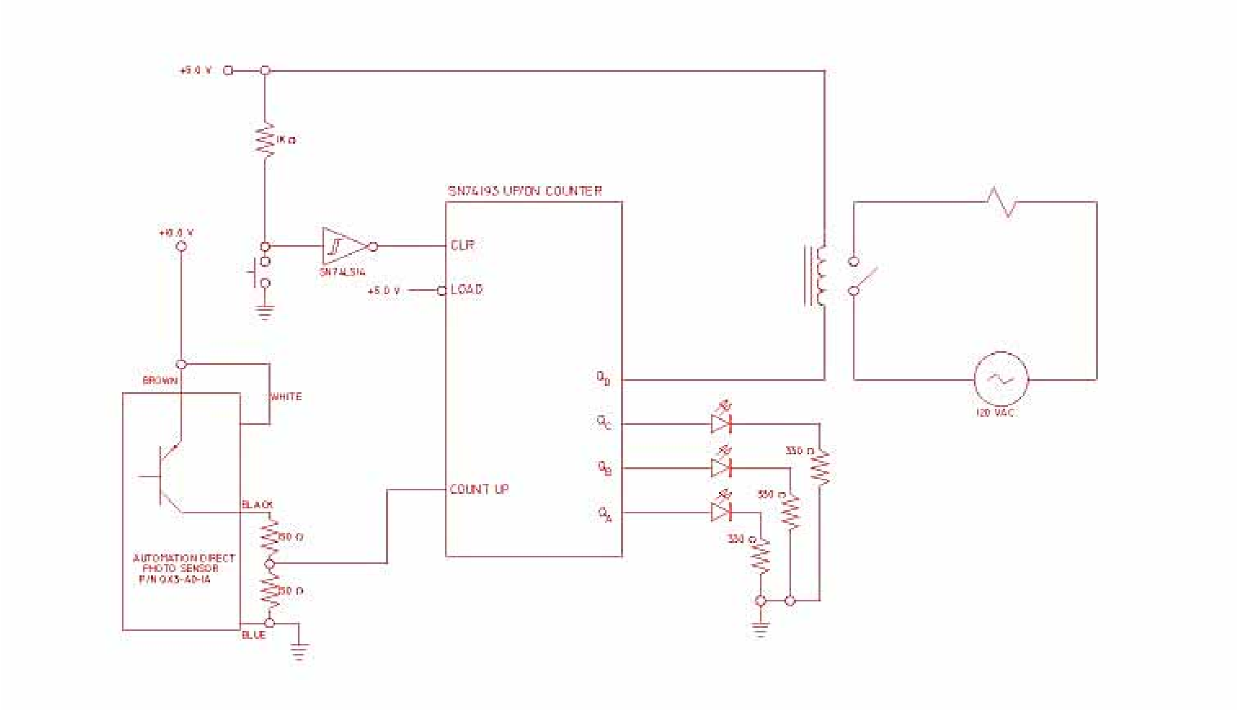

Figure 5: Digital Experiment using Real Life Input/Output Devices

An FM radio station has created interest on our campus from both technical and non-technical students. Since output power is kept extremely low, the station requires no license and can be an excellent vehicle for the study and application of audio and radio frequency signals. Moreover, students have more fun with oral presentations using this alternate setting. In order to bring more computer usage into the electronics curriculum, students are assigned special automation projects to remotely monitor transmitter voltages and currents or to sequence station programming. Much of the equipment can be procured from radio stations which are happy to donate old audio consoles for educational use, and a transmitter kit can be purchased from Ramsey Electronics for about $250.

An optional activity in our department is membership in the amateur radio club. We have a complete station covering most amateur frequencies. Here, the student may learn packet, television, and radio transmission and can become involved in community activities by providing communications for the annual Christmas parade (in cooperation with the local police department) and the local 5K run. The annual amateur radio school club round-up allows participants to communicate with schools across the nation. The technology is directly applicable to cellular telephone and broadcast industries and gets the attention of prospective employers.

Finally, if you are struggling for ideas, one technique is to get inputs from your own students. Simply ask them what they have always wanted to do in lab or in the lecture. You will get some interesting ideas. Be prepared to let them try out some of their ideas. One possibility is to state in the syllabus which experiments will be assigned and designate a mid-semester date for “open lab” in which they can each choose or design an activity for themselves.

VI. Conclusion

Injecting fun, competition, and real-life applications into the curriculum has improved student interest, attitude, and level of learning. I have mentioned a few of the ways I have discovered to include these in my curriculum, but once you are aware of the effectiveness, you will be able to find the very best techniques to suit your personality and the needs of your own students. I must admit it makes teaching more fun for me. I hope you also will enjoy using some of these ideas.

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Charles Moore has been Electronics Department Head and Associate Professor of Electronics at Arkansas State Technical Institute, Beebe, Arkansas for the past six years. Prior to his move to education, Moore worked 25 years in industry as an electrical engineer in product design and in management. He received B.S. and M.S. degrees in Electrical Engineering from the University of Arkansas in 1967 and 1969, respectively. He has been instrumental in bringing a number of student activities to his campus.