Industry-Based Case-Study Models in Technical Education

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I. Introduction

One of the greatest challenges that many students face during their course of study in engineering and technological education is relating classroom topics to real-life situations. Students in their first circuit analysis course, for example, may be engaged in solving circuits that are rarely linked to industry-based examples. Moreover, active and collaborative learning are not widely used when such problems are being solved. For this reason, many engineering and technology students are often frustrated and sometimes lose interest in finishing up their degrees. Furthermore, new graduates face additional challenges in the workplace such as working in multi-disciplinary teams, using oral and written communication skills effectively, and dealing with complex and open-ended problems. To address these growing concerns, faculties from several institutions across Tennessee, Alabama, and Kentucky pioneered the development and testing of industry-based case studies for the enhancement of engineering and technological education. Models for the development and applications of case studies that are interdisciplinary, multi-media enhanced, open-ended, and use active collaborative learning have been developed, tested and are being disseminated. The work was partially funded by an ATE/NSF grant ($1.8 million).

II. An Applied Approach to Technical Education

One of the newly adopted approaches in technical education to address the above-mentioned growing problems is the use of case studies. One may ask the following question here: Why use case studies in technical education? And the answer is: because case studies have been proven to be effective teaching tools in many fields ranging from business and finance to medical. They allow the student to use his/her critical thinking, problem solving, and logic reasoning abilities. Collaborative education and teamwork can be used effectively in case studies. Integrating the sciences, mathematics, technical writing, and oral communication competencies, as well as the SCANS 2000 skills is made easy through the use of case studies. The use of case studies in engineering and technological education, however, has been somewhat limited. Currently, educators are more and more interested in incorporating case studies in their courses. As a result, there are growing needs and interests in industry-based case studies in these fields.

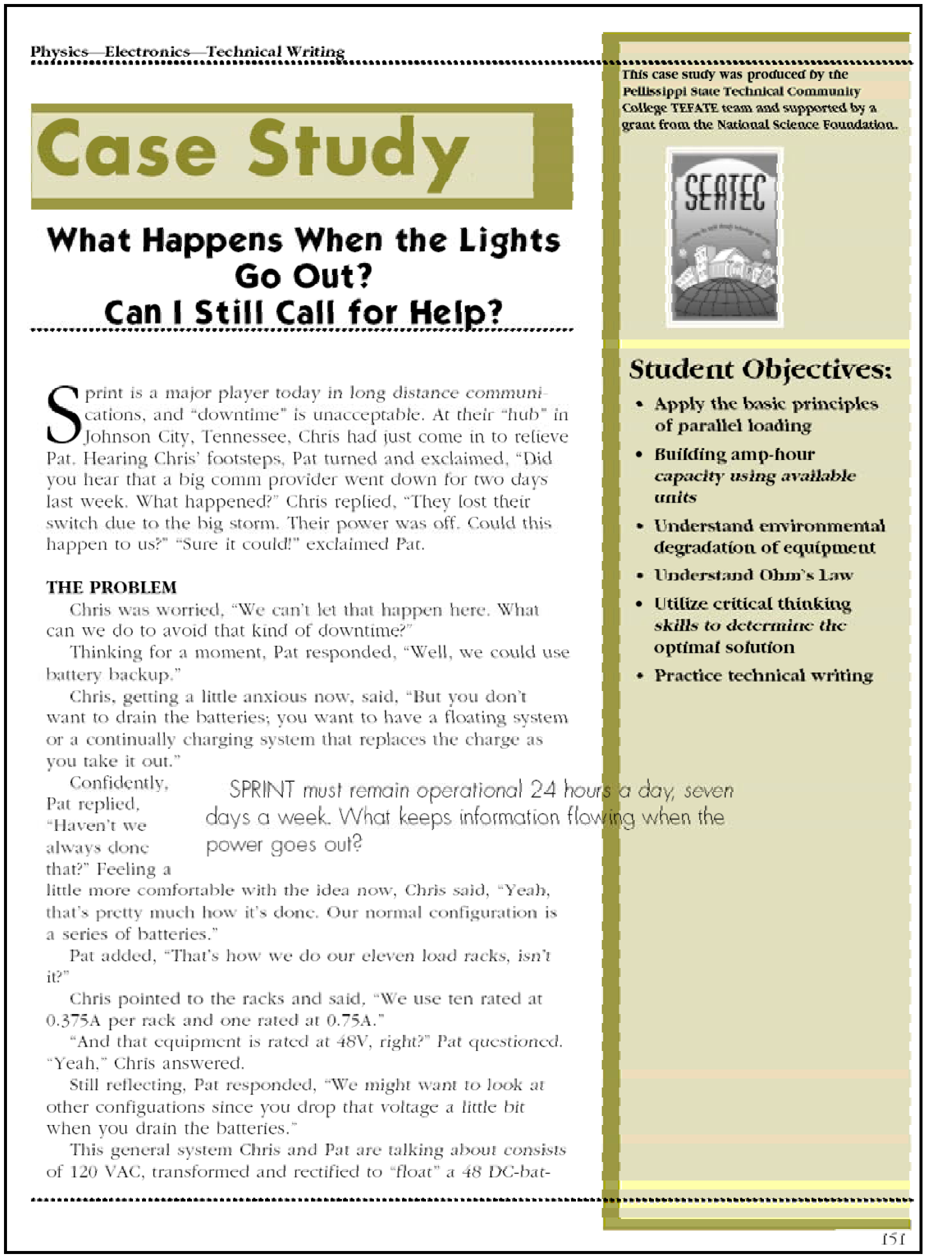
The current paper presents examples of industry-based case studies that can be used in courses such as DC/AC circuits, engineering fundamentals, thermodynamics, and physics. The paper will focus, in particular, on two case studies that the author has developed. Field-testing results and a summary of findings will be also presented.

III. Introduction to Case-Based Learning

Since most students in introductory technical courses are not yet familiar with case studies nor they are comfortable with the concept of working in teams, a “short” pilot case is initially introduced. The main objective of this first case is to introduce the student to case-based learning and collaborative education. The role of the instructor here is more of a facilitator rather than a teacher. The students are engaged in activities that familiarize them with teamwork, leadership, conflict resolution, critical thinking and logic reasoning, and the required oral and written communication skills.

The case deals with a simplified problem of connecting batteries in series and parallel configuration to provide a continuous operation of a telephony system. The case is entitled “What Happens When the Lights Go Out? Can I Still Call for Help?” and was inspired from a visit to the Sprint telecommunication hub in Johnson City, Tennessee.

The students are divided into teams and each team is given one copy of the case. Each team selects a team name, a leader, and a reporter. The students are asked to address the questions in the case, with help from the instructor. Then, the students are asked to work on the case and finalize their results outside class.



Physics—Electronics—Technical Writing

Case Study

What Happens When the Lights Go Out? Can I Still Call for Help?

Sprint is a major player today in long distance communications, and “downtime” is unacceptable. At their “hub” in Johnson City, Tennessee, Chris had just come in to relieve Pat. Hearing Chris’ footsteps, Pat turned and exclaimed, “Did you hear that a big comm provider went down for two days last week. What happened?” Chris replied, “They lost their switch due to the big storm. Their power was off. Could this happen to us?” “Sure it could!” exclaimed Pat.

THE PROBLEM

Chris was worried, “We can’t let that happen here. What can we do to avoid that kind of downtime?”

Thinking for a moment, Pat responded, “Well, we could use battery backup.”

Chris, getting a little anxious now, said, “But you don’t want to drain the batteries; you want to have a floating system or a continually charging system that replaces the charge as you take it out.”

SPRINT must remain operational 24 hours a day, seven days a week. What keeps information flowing when the power goes out?

Confidently, Pat replied, “Haven’t we always done that?” Feeling a little more comfortable with the idea now, Chris said, “Yeah, that’s pretty much how it’s done. Our normal configuration is a series of batteries.”

Pat added, “That’s how we do our eleven load racks, isn’t it?”

Chris pointed to the racks and said, “We use ten rated at 0.375A per rack and one rated at 0.75A.”

“And that equipment is rated at 48V, right?” Pat questioned.

“Yeah,” Chris answered.

Still reflecting, Pat responded, “We might want to look at other configuations since you drop that voltage a little bit when you drain the batteries.”

This general system Chris and Pat are talking about consists of 120 VAC, transformed and rectified to “float” a 48 DC-bat-

This case study was produced by the Pellissippi State Technical Community College TEFATE team and supported by a grant from the National Science Foundation.

SEATEC

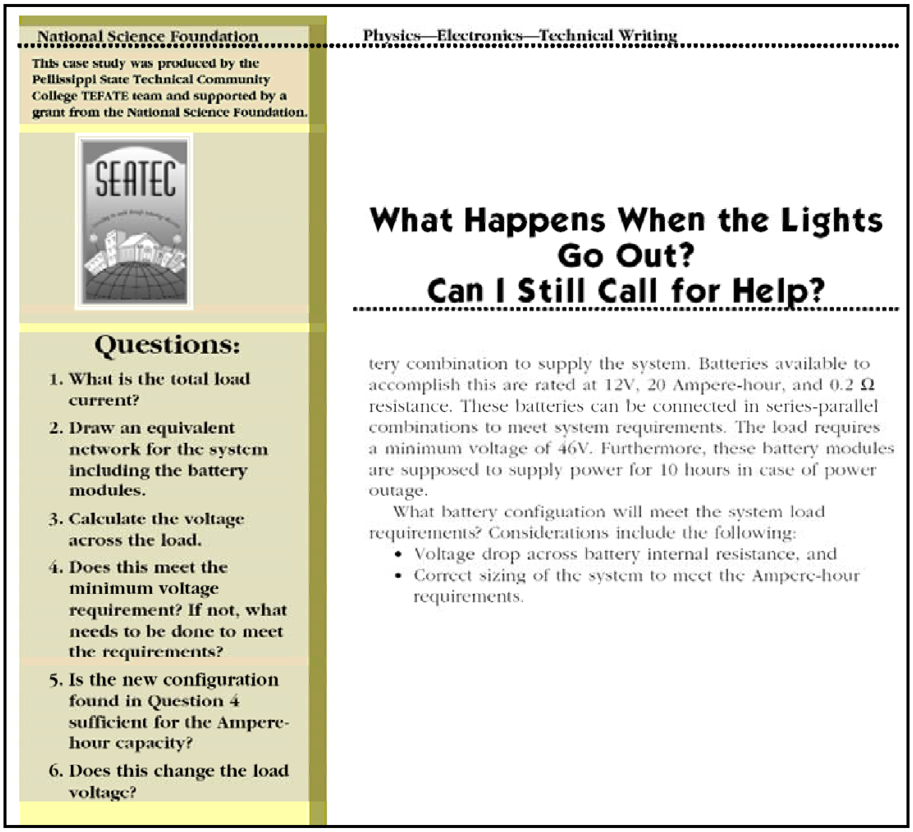
Student Objectives:

- Apply the basic principles of parallel loading
- Building amp-hour capacity using available units
- Understand environmental degradation of equipment
- Understand Ohm’s Law
- Utilize critical thinking skills to determine the optimal solution
- Practice technical writing

151

Finally, each team was asked to present its findings to the whole class and write a short report that includes the results and summary of the students experience in case-based learning including any problems that they may have faced.

The feedback from the students was overwhelmingly positive, which paves the road for introducing the second case. This case is available from: http://www.nsti.tec.tn.us/SEATEC/pages_cases/frame2_cases-3.html



IV. A More Challenging Case

The author has written and co-produced several cases, one of which is gaining popularity among students and educators. It is based on the pizza warmer that the Electrical Product Division of Heatcraft in Murfreesboro, TN has developed. The material being used for the heating element is made of a revolutionary sheet of polymer, which is impregnated with carbon-composition materials that is called Polytherm™. Polytherm™ sheets come in various thickness and widths. The case has several tracks that appeal to wide range of users. In the circuit analysis track of this case, the student is lead through a series of humorous events to the design steps and procedure of the polymer-based pizza warmer. Visual aides are provided throughout the case, including photos of various Polytherm™ designs, the pizza warmer under study, and its detailed schematic diagram that includes all dimensions, material properties, components, and wiring diagram (Fig. 1.a and 1.b). While navigating through the case, the student is faced with "challenges," small problems, and is asked to address these challenges with his/her teammates. The main challenge here is to model the pizza warmer's electrical circuit and to solve for the total resistance, current, power, and energy consumption. The case can also take various other tracks such as product design, thermodynamics/heat transfer, and/or business applications (engineering economy). The pizza warmer heating element and its schematic diagram are shown below.

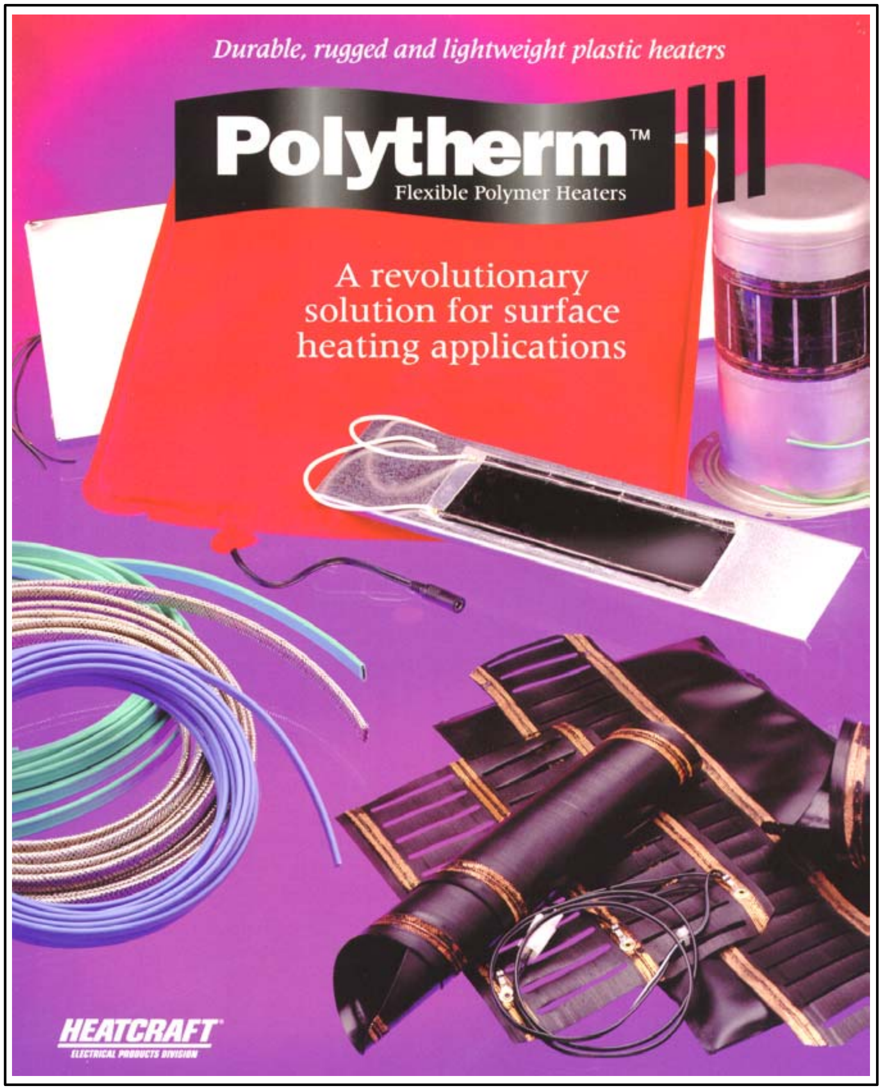


Figure 1. a. Polytherm^{TM} Pizza Warmer with an Optional 120 V Adapter.

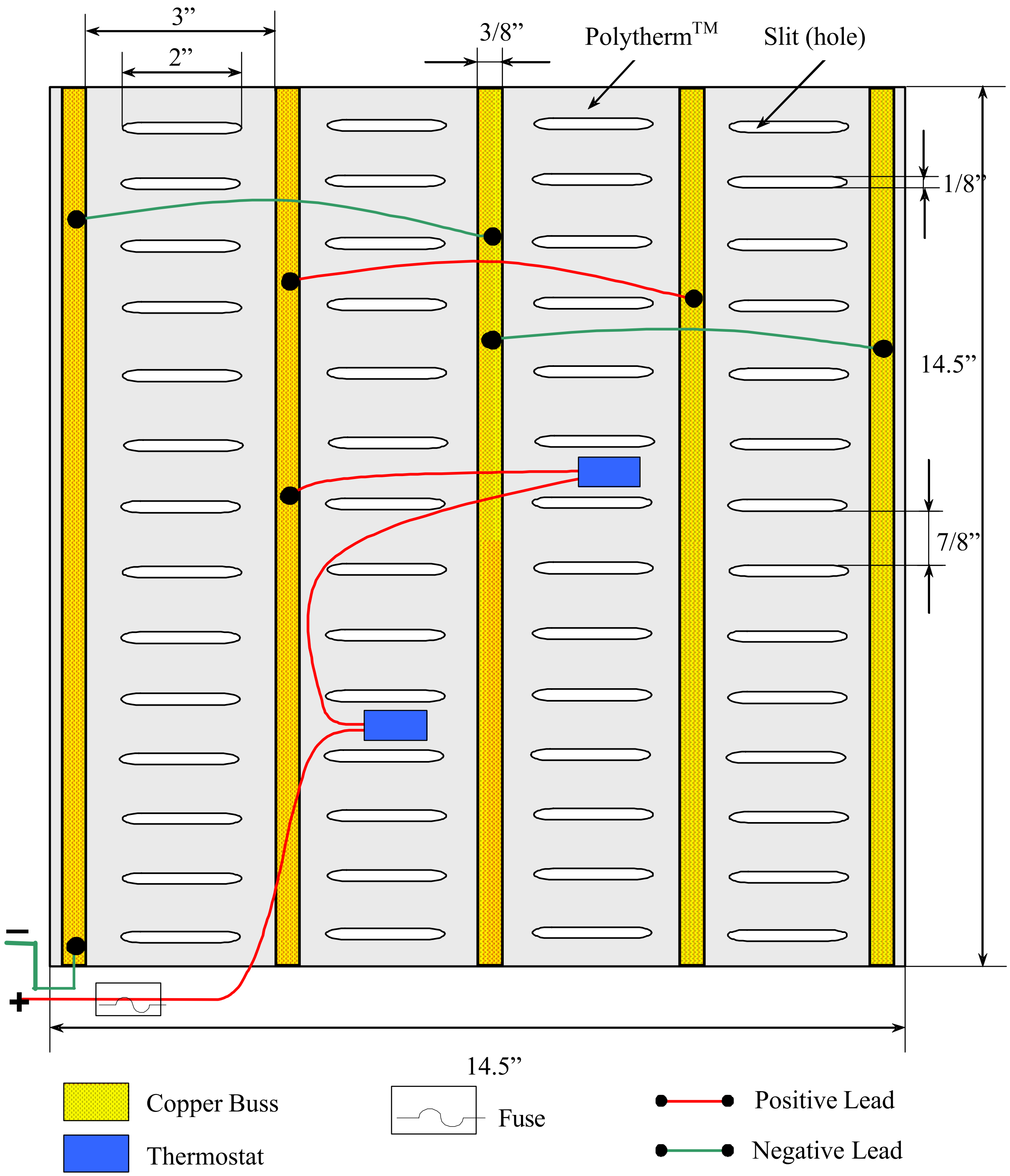


Figure 1.b. Polytherm™ Pizza Warmer Heating Element.

The case is entitled "I Want My Pizza Hot" with the following initial student objectives: Model a real electrical load into an electrical circuit; calculate the resistance of a material from its physical parameters; apply Ohm's law in DC circuit analysis; calculate power and energy; use critical thinking and apply basic algebra in problem solving; and use oral and written communications skills to present data and conclusions.

While working in teams to solve the case, the student navigates through an exciting story that indirectly focuses his/her attention on solving the main problem. The student is asked also to solve small problems or "challenges" throughout the case, which are designed to stimulate critical thinking and logic reasoning abilities. The complete case is available from http://www.nsti.tec.tn.us/SEATEC/.

V. Field Testing Results

The students worked on the pizza case for about a three-week period, mostly outside the classroom. They presented their findings in teams both orally using PowerPoint and in written format. In order to assess the effectiveness of the case method, the author has devised a set of "Transfer" questions that were given during the final. The final test was given about two months after finishing the case. The students were asked to find the resistances of three different shapes: a cylindrical wire (conventional resistance problem), a block of semiconductor, and a thin carbon-fiber sheet. The questions were distributed throughout the test. These text problems are not accompanied by 3-D figures, which may help the student visualize current flow. After finishing this first part of the final and turning it in, a second set of questions with 3-D figures were given to see if the student can be cued using visual aids.

To compare the outcomes of the case method, the author used another section of the same class as a control section. The author taught the two sections and covered the same materials with the exception that cases were not used in the control section. The preliminary results indicate that the case method has helped the students in applying what they have learned to other resistor shapes and forms. They also indicate that the case method has helped the student in retaining the knowledge gained by solving the case longer than that gained in conventional teaching method.

Results from the field-testing of the model case "I want My Pizza Hot!" over the past two years have indicated clear and significant improvements in students' performance in the case sections when compared to students' performance in the "control" sections where a "traditional" teaching environment was used.

VI. References

1. P.K. Raju, C.S. Sankar, and G. Halpin, Proceedings of the Frontiers in Education Conference,

San Juan, Puerto Rico, November 10-14, 1999, pp. 11a2-1-6.
2. C. J. Finelli, Proceedings of the Frontiers in Education Conference, San Juan, Puerto Rico, November 10-14, 1999, pp. 11a25-29.
3. A. McKenna and A. Agogino, Proceedings of the 1998 ASEE Annual Conference, Session 1280.
4. Bransford, Brown, and Cocking, *How People Learn: Brain, Mind, Experience, and School*, 1999, ISBN 0-309-06557-7.

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Dr. Saleh M. Sbenaty is currently an Associate Professor of Engineering Technology at Middle Tennessee State University. He received the BS degree in Electrical Engineering from Damascus University, Syria and the MS and Ph.D. degrees in EE from Tennessee Tech. University. He is actively engaged in curriculum development for engineering and technological education. He has written and co-authored several case studies. He is also conducting research in the area of mass spectrometry, power electronics, instrumentation, and lasers.