Why Should Cases be Integrated into the Engineering Technology Curriculum?

James L. Barrott
Chattanooga State Technical Community College

I. Introduction

The case method of instruction was first introduced in 1870 at the Harvard Law School. In 1908, the Harvard Graduate School of Administration was formed and its curriculum was based on practical case studies. Today, medicine, human behavioral sciences, education, law, business, applied physical sciences, and engineering faculty successfully use the case method of instruction. The movement in engineering case development and classroom teaching has its origins in the 1960's at Stanford University. The American Society of Engineering Education (ASEE) and the Rose-Holman Institute of Technology sponsor an engineering case website that has about 350 case studies[1]. The presence of this website leads one to believe that some engineering and engineering technology faculty members use real-world case studies.

The advantages for integrating cases into any curriculum abound in the literature. These can be generalized into four categories: 1) cases provide students with a link to the real world; 2) cases develop students' critical thinking and problem solving skills; 3) cases develop students' communication skills; and, 4) cases involve students in a cooperative learning activity.

The aim of this paper is to expound upon these four advantages in such a way that an engineering technology faculty member will see the benefits of teaching with cases and then make necessary pedagogical changes to their curriculum so that they can teach cases on a regular basis.

II. Cases Provide Students with a Link to the Real World

Students need "opportunities to link the theoretical constructs developed in the classroom with the practical application in the workforce[2]." Perhaps the greatest advantage for using cases is that successful cases focus students on applications in the workforce by solving real world problems. Many graduates of technical programs suffer from their inability to link academics to the workplace. They lack the ability to define and solve open-ended problems that resemble real-world problems[3]. Cases can be used to bridge the gap between academics and the real world and provide the necessary missing link that is needed between the classroom and the workplace[4].

Several methods of bringing real-world experience into the classroom are widely used and accepted by faculty - cooperative education opportunities or internships, guest speakers, teacher experiences, business/industrial site tours, student projects, and cases. The aim of each method

is to increase a student's ability to quickly adjust into the real world of work and be a productive worker[5]. Each method has its strengths and weaknesses for bringing real world experience into the classroom and a teacher may have varying objectives for using a particular method. The strengths of the case method are that it brings a real world industrial setting into the classroom, presents students with a real world problem, then expects students to propose and defend a real world solution[6]. The outcome is a desirable one, students thinking and acting like they are in the real world.

Berg[7] wrote, "High-quality case studies often have the characteristics of a "mother lode," providing a rich vein of ideas, findings, and methods and a source of learning and stimulation for years after such cases are published. Once you read a good case study, you never see the world the same again."

Fuchs[8] wrote, "Cases give teachers the best opportunity to introduce "outside" reality into the classroom, and outside reality is a vital but costly ingredient of engineering education."

Brockmann[9] wrote, "The case method can be one of the most effective ways to integrate the commercial world with the academic world… Classes may not be able to visit industrial sites physically, yet the problems of industrial sites can daily be brought into the classroom in the pages of a case."

Clearly, the voices of experienced professionals join in proclaiming that good cases bring the real world into the classroom.

III. Cases Develop Students' Critical Thinking and Problem Solving Skills

Cases are intended to simulate the real world and as in the real world, cases do not contain all the information desired. To fill in the gaps, students must use a variety of problem-solving skills including intuition and inductive/deductive reasoning to "read between the lines[10, 11]."

Practical methods for analyzing cases allow students to practice critical thinking skills and to reason through all the information such as facts, figures, and data that are presented in a case. Also, the student must practice other critical thinking skills analyzing, synthesizing, and drawing inferences from the information to solve a problem[12].

Teachers have incorporated several approaches for case analysis in an attempt to develop the critical thinking and analytical skills of students. A recent approach proposed by Friedman[13] suggests a way for "analyzing cases that emphasizes and develops one's ability in logic and effective argumentation." His method is based on a trend in German philosophy to think in triads, "sometimes called dialectical thinking." It is called the triadic method. The "triadic method challenges the students to create opposing views, evaluate them fairly, and demonstrate that they have contemplated the relative strengths and weaknesses of contesting standpoints[14]." This method forces students to produce well-reasoned arguments for not one but many

alternatives. By so doing, the students develop the ability to find opposing views and support the views with rational arguments.

In technical education programs, programs steeped in mathematical and science applications, students are conditioned to look for the one right answer. For example, 2+2 always equals 4. It is heresy to suggest another answer, thank goodness. But, in the real world, answers to complex, perplexing technical problems are not always as concrete as 2+2 equals 4. Yet technical students have little experience looking for alternative answers and then composing rational, well-reasoned arguments supporting each alternative. The triadic method of problem analysis forces the student into critical thinking processes. Good cases are designed to promote critical thinking skills that require students to analyze, synthesize, draw inferences and comparisons, and think reasonably about alternatives[15, 16].

IV. Cases Develop Students' Communication Skills

Essentially, two models for case presentation are used, one is teacher-led and the other is student-led. In the teacher-led model, the teacher shapes the group discussions toward an answer. In the student-led model the teacher's role is more like that of a coach. In either model, the students participate in the case analysis using both oral and written communications. However, in the student-led model, the responsibility to ensure the success of the case falls more to the students[17, 18].

The success of case analysis lies in the active participation of students. As Wright [19] points out, "students need to air their thoughts freely to consider other views, and ultimately come to a group consensus on solutions to the various problems presented." By doing so, students develop and practice important communication skills needed in the workforce in several ways. First, students develop the ability to articulate points of view in both large and small group discussions. Second, students develop the ability to present a point and to think on one's feet as case alternatives are presented. Third, students develop the ability to create alternative solutions and rationally express the strengths and weaknesses of each alternative. Barnes et. al.[20] point out "one strength of the case method is that it encourages participants to defend their positions." Fourth, the students develop public speaking skills and the ability to persuade an audience on various points[21].

Oral communications is necessary to the success of a case. The teacher requiring written reports of the case analysis can also enhance written communication skills in either the teacher-led or student-led model. The report format can be such that students will write reports that simulate proposals normally required in the workplace[22, 23].

V. Cases Involve Students in a Cooperative Learning Activity

Cooperative learning strategies involve students in the learning process through interactive, participatory, and discussion-lead activities[24]. Why is this important for the case method?

For decades, educators have proven that various learning methods affect the retention rates of the learner. The data[25]:

Learning Method	Retention By Learner
What They Read	10%
What They Hear	26%
What They See	30%
What They See and Hear	50%
What They Say	70%
What They Say As They Do Something	90%

Cooperative learning strategies move students through the range of learning methods, from the top to the bottom thus increasing their retention of learning[26].

In 1984, David Kolb published a learning style inventory to help people assess their learning style. Through several studies, Kolb found that learners will self-report themselves into one of four learning stages – concrete experience (feeling), reflective observation (watching), abstract conceptualization (thinking), and active experimentation (doing). He believes learners will select the one learning stage most suited for them and yet the ability to learn more effectively increases by moving from one learning stage to another. He modeled the four stages of learning in the Kolb's Four-Stage Learning Cycle[27].

Stice[28] believes that to be an effective learner, once must move around the four stages in Kolb's Learning Cycle. By doing so, the learner moves from getting involved, to listening, to creating an idea, and to acting or deciding. The case method moves the learner from one stage in the learning cycle to the next and typically follows a series of events. The events of the case method are 1) reviewing the content of the case; 2) identifying and discussing the problems, issues, and data; 3) analyzing and synthesizing the relevant information; 4) developing and defending alternatives; and, 5) pursuing a course of action[29, 30, 31]. As students participate in the events of the case method, learning is enhanced and retention is increased[32].

One of the many cooperative education strategies used by teachers in the classroom today is making use of cooperative learning groups or teams[33]. The case method lends itself well to the use of teams. By drawing upon the collective strengths of team members, case analysis becomes more thorough, the strengths and weaknesses of alternatives are more carefully considered, solutions are more easily defended, and the best solutions rise to the top[34].

As in most cooperative education strategies, teacher roles change when using the case method. The teacher is no longer a lecturer behind a podium. The teacher becomes more of a guide or coach in facilitating the learning process[35]. Williams [36] sees primarily three roles for the teacher: tutoring, serving as a subject matter consultant for students, and developing course materials. Needless to say, many teachers have difficulty adjusting to this style of teaching. Many teachers

believe that since the lecture method worked fine when they were in college and it should be fine for the students in their class. After rethinking the way she teaches and including more case teaching, Maryann Cusimano[37] believes she is more exhausted after teaching. She has "to monitor and mediate both the content and the process of discussion and must … listen to the students." Many teachers are not willing to invest themselves in their teaching to that extent. Also, finding time to research and develop cases is not easy[38]. However, for those who use the case method, the rewards are worth it - students typically remember better for a longer period of time and the classroom becomes dynamic and more enjoyable[39].

VI. A National Study on the Use of Cases in the Engineering Technology Classroom

The reasons for using case studies in an engineering technology curriculum, as outlined in this paper, are significant and they should arouse the desires of engineering technology faculty to integrate cases into their curricula. However, the lack of documentation in the literature on the use of cases by engineering technology faculty raises several questions. Do engineering technology faculty members use cases in their teaching? If not, why? At the publishing deadline for this paper, a national study of engineering technology faculty members teaching in ABET accredited, A.S. engineering technology programs was being conducted to help uncover the answers to these and other related questions. Of 1181 engineering technology faculty members nationwide, a random sample of 618 was chosen to participate. A survey was sent to these faculty members with questions about their use of cases in the classroom. The study will be completed in the spring of 2001. Of the 87 surveys returned thus far, 39 engineering technology faculty members (45%) state that they use cases in their classroom. Their reasons vary but nearly all respondents agree that bringing real-world applications into the classroom is very important. James L. Barrott will publish the results of this national study in a doctoral dissertation.

VII. Conclusions

Engineering technology faculty members may find compelling reasons to integrate cases into their curricula when they discover that cases provide students with a link to the real world, develop students' critical thinking and problem solving skills, develop students' communication skills, and involve students in a cooperative learning activity. Also, they may find that teaching with cases may necessitate dynamic change to stay abreast of pedagogy changes already made by some of their colleagues.

Bibliography

1. http://www.civeng.carleton.ca/ECL/
2. Wright, S. (1996). Case Based Education: Linking Theory To Practice. Physical Educator, 53(4), 190-208.
3. Flammer, G. H. (1977). The Case Study: Exercise In Simulation. Engineering Education, 67, 372-373.
4. Fuchs, H. O. (1970). Outside Reality Inside The Classroom. Engineering Education, 61, 745-747.

5. Ibid, Fuchs.
6. Brockman, J. R. (1993). What Is A Case? . The Case Method In Technical Communication: Theory and Models. (Fourth ed.). ATTW.
7. Berg, D. N. (1990). A Case In Print. Journal of Applied Behavioral Science, 26(1), 65-69.
8. Ibid, Fuchs.
9. Ibid, Brockman.
10. Merseth, K. K. (1991). The Early History Of Case-Based Instruction: Insights For Teacher Education Today. Journal of Teahcer Education, 42(4), 243-250.
11. Stewart, K. A. & Winn, J. (1996). The Case Debate: A New Approach To Case Teaching. Journal of Management Education, 20(1), 48-60.
12. Friedman, W. H. (1995). A New Model For Case Analysis: Iterative Triadic Thinking. Journal of Education For Business, 70(4), 228-233.
13. Ibid, Friedman.
14. Ibid, Friedman.
15. Ibid, Friedman.
16. Ibid, Stewart & Winn.
17. Droge, C. & Spreng, R. (1996). Enhancing Involvement And Skills With A Student-Led Method Of Case Analysis. Journal of Marketing Education, 18(3), 25-35.
18. Vesper, K. H. (1978). An Easier Way To Teach With Engineering Cases. Engineering Education, 68, 349-351.
19. Ibid, Wright.
20. Barnes, L. B., Christensen, R. C. & Hansen, A. J. (1994). Teaching The Case Method. (Third ed.). Boston, Massachusetts: Harvard Business School Press.
21. Cusimano, M. K. (1995) Why Do You Do What You Do In The Way You Do It? Examining Teaching Goals And Teaching Methods. csf.colorado.edu:70/00/csf-lists/casenet/About_Case_Teaching/Cases_and_Effective_Teaching.Cusimano. Downloaded, August 6, 1998.
22. Ibid, Droge and Spreng.
23. Ibid, Wright.
24. Ibid, Cusimano.
25. Stice, J. E. (1987). Using Kolb's Learning Cycle To Improve Student Learning. Engineering Education. Feb, 291-296.
26. Johnson, D. W., Johnson, R. T., and Smith, K. A. (1991). Active Learning: Cooperation In The Classroom. Edina, Minnesota: Interaction Book Company.
27. Kolb, D. A. (1984). Experiential Learning: Experience As The Source Of Learning And Development. (First ed.) Englewood Cliffs, New Jersey: Prentice-Hall.
28. Ibid, Stice.
29. Grant, R. (1997). A Claim For The Case Method In The Teaching Of Geography. Journal of Geography in Higher Education, 21(2), 171-186.
30. Green, M. M. (1993). How To Use Case Studies In The Classroom. The Case Method In Technical Communication: Theory and Models. (Fourth ed.). ATTW.
31. Richardson, C. P. (1997). Using Case Studies In The Methods Classroom. Music Educators Journal, 84(2), 17-23.
32. Ibid, Stice.
33. Ibid, Johnson.
34. White, L. F. (1998). Motivating Students To Become More Responsible For Learning. College Student Journal, 32(2), 190-197.
35. Ibid, Cusimano.
36. Williams, S. M. (1991). Putting Case-Based Instruction Into Context: Examples From Legal And Medical Education. The Journal Of The Learning Sciences, 2(24), 367-427.
37. Ibid, Cusimano.
38. Wheatley, J. (1986). The Use Of Case Studies In The Science Classroom. Journal Of College Science Teaching,

15(5), 428-431.
39. Ibid, Cusimano.

JAMES L. BARROTT
James Barrott received a B.S. degree from Brigham Young University in Design Engineering Technology, a M.S. from the University of Tennessee-Chattanooga in Engineering Management, and he is presently a doctoral candidate at the University of Tennessee-Knoxville. He worked as a CAD/CAM Specialist for the General Electric Company before joining Chattanooga State Technical Community College where he presently serves as the Dean of the Engineering, Environmental, and Emergency Technologies Division and teaches design and manufacturing courses.