Implementing “Student-Centered” Case Studies

David Myszka
University of Dayton

Abstract

Many fundamental courses in an engineering technology curriculum are primarily concerned with the analysis of simple devices. For the example of an introductory mechanics course, forces and motions of levers and bars are studied. Many instructors believe that the complexities of commercial machinery are beyond the student’s current abilities. Students eventually have the opportunity to study the details of machine components in upper-level courses, once the fundamentals are mastered. However, students in the preparatory courses often struggle to see the relevance of such rudimentary analysis, which often results in fading interest.

To engage the students and explore real-world applications in the fundamental courses, some instructors began using a case study method of instruction. Studies have shown that under proper conditions, this approach can be tremendously successful. This paper investigates having the students, themselves, preparing and using this case study approach. These “student-centered” case studies allow the students to gain a better understanding and demonstrate their analysis skills, along with enhancing their oral communication skills. Most importantly, the case studies bring excitement and enthusiasm to the classroom.

Introduction

Case studies are stories with an educational message. They are not simply narratives for entertainment, but they are meant to teach. Parables have been used as a teaching tool for centuries. When used effectively in a formal setting, a case study engages the students to examine and dissect a narrative description of an actual situation. Additionally, it challenges the students to analyze the situation and formulate an opinion. In the classroom, the case study approach promotes active learning, team based activities, and the ability to deal with open-ended problems.

Business and law schools have a long tradition of using real or simulated stories, known as cases, to teach students about their field. Christensen\(^4\) explains that Harvard University has been the leader in developing cases in these subjects, and has produced faculty who have carried their enthusiasm for that method to other institutions. Mauffette-Leenders, et-al.,\(^7\) lists numerous books that have been written about the pedagogy of the case study method. Other disciplines such as medicine, psychology, and teacher's education also have used the method to capture the imagination of students.
In contrast, case studies have not been so popular in technical subject areas, except as an occasional story told by an instructor. Engineering is often considered a study of concepts, principles and scientific phenomena. On the surface, this situation appears to demand single path solutions with correct answers. However, Fitzgerald has documented a handful of case development projects for engineering education.

These early adopters of engineering case studies saw the value of fact-driven cases, which have multiple solutions because of insufficient data or emotions are involved, and business, ethical or political decisions are at stake. These cases can bring much needed realism to the classroom. They provide a context for the application of knowledge from the technical courses.

Case Studies with Commercial Products

Traditionally, case studies involve a scenario, which includes enough background information to allow for a significant analysis. Even the technical case studies focus on the design or business process behind the situation. Noteworthy cases, such as the Challenger accident and the failure of Firestone tires, have larger strategic issues that diminish the technical lessons. While it is good for engineering professionals to understand the greater context, focus on the technical issues is also needed.

In fact, an investigation of any commercial product can serve as an effective case study. This is especially true in fundamental mechanics courses. In these courses, students are often unable to visualize an application for the basic principles. Yet, dissecting the documentation for a commercial product can expose the relevance of the basic principles. Marketing descriptions, operator instructions, maintenance procedures and replacement part diagrams provide excellent background for a case study. When coupled with an objective statement, or a series of directed questions, the students can begin an exploration into many facets of the product. Examples of directed questions include:

- Discuss features that could be added to the product that would appeal to a larger market. Also, determine the components would need to be replaced or upgraded.
- Determine the orientations of the machine that would require the greatest effort from the actuator and the orientations that place the greatest loads on the bearings.
- Inspect the motion of the drive mechanism and select alternate devices to accomplish the same task.

What Makes a Good Case

Of course, not cases are created equal. Some are better than others. Bennett and Chakravarthy published the results of detailed interviews and questionnaires of faculty and students. Later, Robyn compiled several studies, classifying the elements of a good case study. The following guidelines stem from their conclusions:
A good case focuses on an appealing issue or product. To maximize interest, the students should have first-hand knowledge of the issue or product. Ideally, a product would be exciting and fun to use. Issues should be chosen that involve situations that the students know or are likely to face. This improves the empathy factor and makes the case clearly something worth studying.

A good case is set in the past five years. Unless a case deals with current issues and the student feels the problem is important, some of its power is lost. If a student has just seen the product mentioned in the media, so much the better.

A good case must have pedagogic utility. Only an educator would use this jargon, but the point is valid. What function will the case serve? What does it do for the course and the student? What is the point of the story in the education of the student and is there a better way to do it?

A good case is conflict provoking. Cases are particularly appealing if it contains something controversial. If it contains an issue where reasonable people could disagree or if a product has some misleading marketing information, you have the beginning of a good case.

A good case is decision forcing. Not all cases have to be dilemmas that need to be solved, but there is a seriousness that is involved with such cases. In dilemma or decision cases, students cannot duck the issue, they must face problems head on. When they are forced to take a position, they are thrust into the action of the case.

A good case has generality. What good is a case that is so specific that one can use it only as a curiosity? Cases must be of more use than a local problem or isolated product; certain aspects must have general applicability.

A good case is short. It is simply a matter of attention. It is easier to hold someone's attention for brief moments than long ones. Cases must be long enough to introduce the facts of the case but not so long as to bore the reader or to make the analysis tedious. If one must introduce complexity, let it be done in stages. First, give some data and then a series of questions and perhaps a decision point before more information is introduced. After all, that is the way life plays out...little bits at a time.

Case Studies in the Age of the Internet

Modern computer and communications technology can greatly enhance and enrich the case method. Engineering cases usually involve substantial amounts of graphic information and numerical data. The World Wide Web is a tremendous resource. Consumer and technical information on virtually any type of commercial products can be quickly located. Product information, such as to marketing material, technical
specifications, operator’s manuals, exploded assembly drawings intended for ordering replacement parts, and many other descriptive facets, is readily available.

With the internet, we all have access to far more information than any single university could provide. Often the students can, and do, explore things their professors don’t yet know. Additionally, much of the product the information has entertainment value and can be “flashy”. A well-prepared case can include movie clips and animated sequences as well as standard diagrams and images. In these formats, cases can be highly interactive and exciting.

Student Centered Activities

Student centered teaching should be at the core of any effective classroom. The main idea behind the practice is that learning is most meaningful when topics are relevant to the students’ lives, needs, and interests and when the students themselves are actively engaged in creating, understanding, and connecting to knowledge. Armstrong, et.al., show that students will have a higher motivation to learn when they feel they have a real stake in their own learning.

In student centered teaching, the planning, teaching, and assessment must be focused on the needs and abilities of the students. Instead of the teacher being the sole source of information, the teacher shares control of the classroom and students are allowed to explore, experiment, and discover on their own. The students are not just memorizing information, but they are allowed to work with and use the information alone or with peers. Their diverse thoughts and perspectives are a necessary input to every class. The students are given choices and are included in the decision-making processes of the classroom.

To implement such a method, students can be asked to create their own case studies. In addition, they are capable of leading the class in the discussion and analysis of the case. These sessions can be quite lively, as the students often find the empowerment exceptionally motivating.

A Typical Assignment

The following description is an example of a student centered case study assigned to a machine dynamics course. Each student is asked to identify a machine that can be extensively examined. The operation of the machine will be presented as a case study to the class on an assigned day.

The study can focus on any machine, which exhibits motion and transmits forces. Research on the internet should be sufficient for this study. Some common machines are

- Sewing machine  
- Bicycle brakes  
- Construction Machinery  
- Overhead garage door  
- Power Tools  
- Farm Machinery  
- Lifting Equipment  
- Automotive Components  
- Exercise Equipment
Early in the semester, a memorandum is required, which identifies, specifically, the machine/mechanism that will be evaluated. Also, at least one web site where information can be gathered must be identified.

The case study presentation should not exceed 10 minutes. The format is flexible and classroom interaction is encouraged. Topics that should be discussed during the presentation include, but are not limited to, the following.

1. A description of the machine, including photograph(s).
2. Identification of the mechanical elements of the mechanism, including a technical sketch(s) of the mechanism being evaluated.
3. Free body diagrams of the different components in your machine.
4. A kinematic sketch of the mechanism and the calculation of the degrees of freedom.
5. A description of the motion that the different links of the mechanism, while the machine is being operated.
6. A description of the force transmission of the different links. These free body diagrams may need to be altered if the forces dramatically change while the machine is being operated.
7. A description of the interesting and/or unique aspects of the design of the machine.

This assignment is not intended to be a large commitment of time, but should give all students the chance to thoroughly observe a mechanism. The students are asked to try and have fun with this and see me if you are having difficulty understanding the motion of your machine.

**Concluding Remarks**

Case studies can be a tremendous method of illustrating the applications of fundamental courses to commercial products. Further, students are fully capable of creating the case studies themselves. This is particularly possible with the enormous amount of information available on the internet.

However, the students need some guidance in preparing a good case study. These are outlined in this paper. Still, even with class time devoted to supplementary topics, the benefits of having the students prepare and present case studies are numerous. It engages the students as they focus on the course information as it applies to products that are of interest to a typical college student. Also, if each student is required to prepare one case study, over the course of a semester, the class is subjected to many different products. Finally, assigning this work to the students is an excellent way to leverage the time of the instructor.


References


DAVID MYSZKA
Dave Myszka is an Associate Professor of Engineering Technology at the University of Dayton. Dave is a Registered Professional Mechanical Engineer in Ohio and is actively involved in applied research with industry. Dave received a B.S. and M.S. degrees in Mechanical Engineering from the State University of New York at Buffalo in 1985 and 1989, respectively. He also received an M.B.A. degree form the University of Dayton in 1996.