CASE METHODOLOGY: ADDRESSING THE QUESTIONS OF HOW AND WHY

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ABSTRACT

The purpose of this paper is to give the reader a better understanding of case methodology used in teaching as opposed to case methodology used in research. Both address the same fundamental issues by asking "how" or "why" questions about a contemporary set of events over which the investigator has little or no control. The case method of research rigorously attempts to answer these questions whereas the case method of teaching attempts to stimulate the students by asking these questions and encouraging the students to ask "how" and "why" questions of their own. By addressing these questions in the case methodology of instruction, education receives two significant benefits. First, students are tasked with applying and honing their critical thinking skills, e.g. defining issues, using sound reasoning, and making decisions. Second, instructors maintain that all important tie with industry through the development and use of cases in the classroom. This paper gives a brief description of the evolution of engineering education that emphasizes the need for new teaching methods addressing the needs of educators, students, and industry. This paper will also enlighten the reader on case teaching by presenting a historical account of how case methods of teaching were initially developed and where they are commonly used today. Next, a description is given of what the case method of teaching is and, just as important, what it is not. Finally, the importance of case methodology in engineering research and its potential impact on case methodology in engineering education are discussed.

INTRODUCTION

Case methodology has been used for decades by Harvard Business School, Harvard Law School and many other well renowned business, law, and medical schools. The educators at these institutions use case methods to bring reality into the classrooms requiring students to think critically about real life issues. Engineering schools today are faced with many of the same dilemmas that caused business schools to incorporate case methodology, namely, how to improve students' thinking and problem solving skills.
In this paper, the authors present basic concepts of "case methodology" and explore its applicability to engineering education. The remainder of the paper is organized as follows: In Section I, the evolution of engineering education is given with an emphasis on a need for change. Section II covers the history of the case method of instruction and a description of its modern implementation. Characteristics of case methodology in teaching are described in Section III. To better understand the difference between case methodology and other tools, the discussion in section IV describes "what is NOT a case." The importance of case methodology in engineering research and its subsequent impact on case methodology in teaching is briefly discussed in Section V. Finally, some arguments for using case methodology in engineering are summarized in the Conclusion.

I. EVOLUTION OF ENGINEERING EDUCATION

Engineering education objectives and methods have progressed greatly during the post-World War II technology boom. During the 1950's, teaching material was characterized by multitudes of design rules for different practice scenarios, i.e. rules of thumb for particular engineering problems. It soon became evident that "cookbook" engineering was insufficient to meet the needs accompanying the rapid growths in new technology and the ever-broadening scope of engineering problems. The emphasis of classroom education shifted in the 1960's toward "engineering science," or the fundamentals of physical phenomena. This constituted an effort to instill in students the necessary foundations for understanding and creating new technology, for which design rules had yet to be written. However, the emphasis on basic science produced engineers who lacked practical experience and judgment, though well-trained in science and mathematics. The call for better experiences in applying science to practical problems brought a response in the 1980's by engineering curricula that supplemented science requirements with "engineering design" mandates. Most recently, engineering educators recognize that these mandates alone are inadequate, because a key ingredient is missing: students are often poorly trained in the processes of putting science into practice. The most glaring shortcoming is the inability of students to think through problems and various solution scenarios. The most recent resolutions from National Science Foundation education conferences[1] and engineering accreditation workshops[2] are to improve engineering students' thinking and problem solving skills, rather than inculcating a heavy emphasis on basic science.

The evolving objectives have been accompanied by significant changes in teaching methods as well. For example, engineering courses have experienced cycles of varying emphasis on laboratory versus lecture content. The engineering education experience of the 1950's was punctuated by heavy laboratory content and the practicing of design rules. As the curriculum objective moved to engineering science, the in-class lecture became the predominant tool for teaching. Rather than being fields for exploration, laboratories and projects changed to provide reinforcement to the lecture content, "sanitizing" problems if necessary to give the desired emphasis on the theory. Technology advances such as the hand-held calculator, desktop computer, and computer graphics workstation are now used to speed calculations, improve presentations, and even automate the teaching processes. These tools have become useful in the goal of presenting science more quickly and in a more interesting fashion. The practice of using computers in engineering curricula has even become a requirement of accreditation. Today, the most common engineering teaching method is the in-class lecture, supplemented by laboratories and projects. Curricula are often designed as a set of courses emphasizing basic science, leading to a capstone "design" experience. The engineering co-op experience is also highly touted to give students exposure to real-world problem solving, but the majority of students do not undertake these programs. Table 1 summarizes the evolution of engineering education since W.W. II.

Table 1: Evolution of Engineering Education

Engineering Education			Teaching Method
1950's	Rules of Thumb (cookbook)	⇒	Laboratory (practice rules)
1960's and 70's	Engineering Science	⇒	In-class Lecture
1980's	Engineering Design	⇒	In-class Lecture, Laboratory and Projects, Capstone Design
1990's	Thinking and Problem Solving (applied to real world problems)	⇒	Combination of others plus new teaching methods

In short, the changes in engineering education and objectives point to the present-day conclusion that problem solving skills are not being effectively instilled in students. Why not? Perhaps the engineer's natural inclination toward exactness tends to promote the importance of the correct final answer to a problem. However, recent discussions among educators points out that teaching methods should be reexamined[1]. How can educators instill thinking and problem solving skills while putting science into practice? Case methodology is a potential key to answering this question.

II. HISTORY OF THE CASE METHOD

In order to appreciate the applicability of case methodology to engineering education, an understanding of its evolution is also necessary. The case method of instruction is most notably tied to the Harvard Business School. The school was established in 1908 and the case method of instruction was used in courses on commercial law. Its use quickly spread to other areas of the school such as the Harvard Law School where they developed their own brand of case methodology. They all possessed the same fundamental objectives as the business school teaching, however, where the central mission was to provide "practical and professional" training to each student[3]. As Dean of the Business School, Edwin Gay brought insight and a desire to prepare students for the demands of the commercial world into the school. "Dean Gay was clearly determined to achieve the objective (practical and professional training) with emphasis on a pedagogy that linked the classroom to the actualities of business and engaged the MBA student in a practice-oriented, problem-solving instructional mode (the case method)... He encouraged faculty to explore not only what they taught but how they taught, a tradition that persists today[3]."

Case methodology continued to evolve throughout the years preceding World War II, but the most significant changes in the use of cases in the classroom occurred immediately following World War II. This happened for two reasons. First, the instructor composition changed considerably at Harvard. Many of the instructors had war experience working with the military and its management structure. Also, new instructors came into Harvard asking difficult and demanding questions about how and why things were done. The second reason came from the fact that the student base changed along with the instructor base. They had different needs and interests primarily motivated by their war experiences. Most of these new students were older and had considerable military experience, many in leadership positions. "Questioning traditional authority patterns, impatient and independent, these men were confident in their ability to participate in the give-and-take of a group discussion and eager to assume responsibility for their own education[3]."

This new demand on instructors by the students changed the way both looked at education. "The impact on the instructor was significant. His new role was less to question a series of individual students than to direct a process by which the section explored a complex case situation. . . Thus a new case method of teaching was born, quietly, over time and in some measure without the faculty's full appreciation of the magnitude and magnificence of the change[3]."

Because of its roots in the Harvard Business School, case methodology has been primarily used in the areas of business and management. There has also been considerable use of this method in law schools because of its basis at the Harvard Law School. The next most frequent use of the case method is in the study and research of social sciences to include psychology, sociology, political science, social work, planning, and economics[4]. There are a number of books and articles proposing the use of cases in engineering, for example Vesper's book on Engineering Case Studies[5], but very little use is made of case methodology in the engineering classroom.

What makes a case so desirable in these circumstances over more common methods of instruction such as lectures, books, field trips and projects and why would cases be an outstanding addition to the engineering classroom? To answer these questions, case methods must be better understood.

III. CASE METHODOLOGY

To understand case methodology the reader has to recognize that the purpose of a teaching case is to "establish a framework for discussion and debate among students[4]." This means teaching objectives or goals must change with the use of case methods of instruction. The first goal is to bring theory into practice by tying the academic theory to real world practical applications. The case is the tool that ties these two areas together. The second goal is to make the students think through and participate in the trouble-shooting and decision processes involved in problem solving. The third goal is to expose the students to multiple levels of the same problem. Case studies allow the instructor to present a multitude of different problems to the students to handle at different levels. The students can take on the rolls of different "players" in the case giving them exposure to different aspects of the same problem. See Figure 1 for a comparison between the traditional teaching process and the case methodology teaching process.

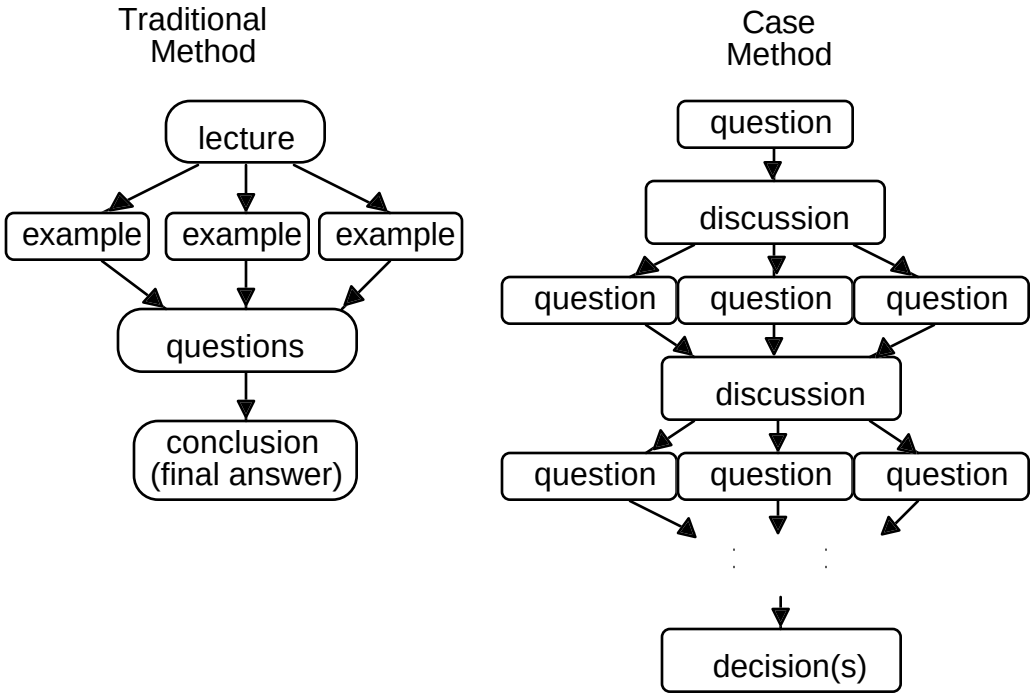

Figure 1: Comparison between Traditional and Case Method of Instruction

Traditional teaching methods (lecture, quiz, or exam) lead to a "global" or "universal" conclusion that can be applied to all or to a broad range of situations. Many examples are usually given with one final solution tying them all together. Cases, on the other hand, deal with specific, unique, situations. Memorizing all the different situations is impractical, so the goal of using cases is to understand the processes involved in attaining a solution to a specific problem. Cases encourage and require students to think about the situation, not just apply rules of thumb. Often students are left with 'open-ended' or 'ill-defined' problems that require them to make decisions based on the limited information they possess. Students also accept a tremendous amount of responsibility for their own learning. The use of cases forces students to determine what is important in the case, what additional information they need to acquire, how to acquire the information and answer the how and why questions involved in the case itself.

Solving the case, however, is not the primary goal. Using the case to enable the students to practice problem solving skills is the goal. It is the journey that is important, not the final destination. Cases are the medium through which the students can practice skills needed for real world problems by allowing the students to make mistakes, speculate on decisions to be made, critique decisions made by others and defend their own decisions. Cases teach the students to think critically about a topic but the topic is not as important as the critical thinking, e.g. defining issues, using sound reasoning, and making decisions.
Paul R. Lawrence summarizes these ideas in his chapter on "The Preparation of Case Material" in The Case Method of Teaching Human Relations and Administration[6]:

> A good case is the vehicle by which a chunk of reality is brought into the classroom to be worked over by the class and instructor. A good case keeps the class discussion grounded upon some of the stubborn facts that must be faced up to in real-life situations. It is the anchor on academic flight of speculation. It is the record of complex situations that must be literally pulled apart and

put together again before the situations can be understood. It is the target for the expression of attitudes and ways of thinking brought into the classroom.

IV. WHAT IS NOT A CASE

Case methodology used in teaching sets a framework for students to develop their critical thinking skills. Critical thinking is a very important part of the larger goal of education; namely, to bridge the gap between abstract theories and the complex world of non-ideal problems, unconventional procedures and the human element. Traditionally, this goal is partially accomplished through other means such as books, lectures, field trips and projects[5]. These all have a contribution to make to education, but each has drawbacks as well. Books are normally organized to present theory and reinforce the theory by presenting idealized examples. The theory is important, but it compromises reality and often lacks the element of practical judgment. Lectures, by far, are the most passive way a student learns. "By listening rather than participating, they derive less from the experiences presented." Field trips, again, are a relatively passive way of learning since the students view the activities of others rather than participating in them. Projects provide in-depth exposure to one particular problem but, because of the time constraints, usually only few projects are possible per learning period.

Case methodology doesn't solve all of these problems but it does give another dimension to education; primarily student involvement at all levels of an issue. The case method brings the real world into the classroom for closer examination than one would receive from a field trip. It is not ideal like one would find in an example from a book. It does not have a preprogrammed, specific outcome as in lecture examples. There is no single, ideal final solution. The real benefit to using case studies is when they can be combined with other means of education to complement each other[5].

It is obvious that the other means of providing education described above are not case studies. It is not so obvious, however, why other examples fail to be case studies. Many authors have written articles and books claiming that they are case studies when in fact they are merely elaborate industrial examples similar to those used in text books. Or they may be a discussion on a specific phenomenon that cannot be generalized, so are termed as a case study because they apply only to this specific situation. Why are these examples not considered case studies? There are two answers to these questions. First, these studies usually fail to ask or answer the "how" and "why" questions so important to actual case studies. Secondly, by failing to answer or ask these questions, these studies do not evoke the critical thinking so significant in case methodology.

V. CASE METHODOLOGY IN ENGINEERING CURRICULA

By reviewing engineering education evolution, case methodology history, and the case method of instruction presented here, engineering educators should be able to answer the questions addressing 'why' engineering education needs change and 'how' to accomplish this change. The future holds many new technologies and it is impossible for academic institutions to keep up with the rapid pace of these new discoveries. But academic institutions have a responsibility to the students, as well as industry, to prepare them for the real world and the future. What better way to prepare the students than through the development of critical thinking! Traditional teaching methods such as lectures and laboratories cannot accomplish this goal alone. Educators must put the students into a position where critical thinking is required. That is where the case method of instruction enters academics.

The driving force that caused Harvard to adopt the use of case methodology, namely process oriented thinking and problem solving skills related to real world situations, is exactly what is driving engineering

educators to search for new ways to fill the gaps in engineering education today. The case method of instruction has evolved and changed over the years based on the needs of the students, insight of the instructors and demands of the real world. The Harvard Business School has proven that case methodology has the ability to grow and evolve with the changing demands of the complex business world. It is time to bring engineering education together with case methodology to meet the need of an ever changing technological world.

CONCLUSION

Case methodology is an interesting and rich means of educating students in real world applications of academic theory. It is essential for educators to instill critical thinking in their students in order to meet the challenges of the non-ideal world that awaits every student. "When the objective is critical thinking .. or problem-solving .. and the development of qualities such as sensitivity, cooperation, and zest for discovery, discussion pedagogy (case methodology) offers substantial advantages. To achieve this complex, value-laden educational goals, both teachers and students must modify their traditional roles and responsibilities[3]." The tools that educators give their students should not be specific solutions to specific problems, but the processes involved in problem solving. To have a student say, "I can solve any problem I've seen before" should tell the educator that they have not done their part in this student's education. Case studies, used properly, can enable the student to challenge those problems they have never seen before and succeed.

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BIOGRAPHY

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