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**AC 2011-2265: ENGINEERING ETHICS CASE STUDIES IN SENIOR UNIT  
OPERATIONS LABORATORY**

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# Engineering Ethics Case Studies in Senior Unit Operations Laboratory

## Abstract

Placement of ethics in the Chemical Engineering curriculum has always been debated. In this project, the use of a real-world engineering ethics case study was integrated into the Senior Unit Operations Laboratory course over two separate class years (i.e. Year 1 and Year 2). The motivation behind this was twofold. First, the assignment provides the opportunity to develop a student's oral communication skills. Although oral presentations were an existing component of the course, this assignment provided a separate and distinct venue for a student to use this skill. More specifically, students were required to use reason and analysis in presenting their final argument. Second, an ethics component in this course would help bridge the transition between college and the workplace. An ethical dilemma involving the choice between doing what is right and maintaining a positive bottom line is often seen in industry. Exposure to previous examples and the decision-making process involved would be beneficial for students.

The case study used was generated by the Laboratory for Innovative Technology and Engineering Education (LITEE), and incorporates several ethical issues and moral challenges that emerge from the interplay of manufacturers, employers, and employees. Prior to presenting the assignment, a short lecture on ethical dilemmas was delivered by the instructor, thus creating a knowledge base for students. Subsequently, students were divided into four constituencies, and asked to review the relevant data from the LITEE website. Each group offered their positions through an oral presentation, and followed up with other questions after all groups have finished. The groups were assessed by attorneys from a local firm.

The ultimate questions in this study are: 1) Do students find it important to study ethics in the context of an engineering program, and 2) Is senior laboratory the best course in the chemical engineering curriculum to insert an ethics project. Results obtained from surveys after Year 1 show that students agreed that it is important to study ethics, but senior lab is not the best venue. Students felt that the assignment was an additional load in a course that is already work intensive. Moreover, they felt that the assignment improved their presentation skills. When surveying after Year 2, students shared the same sentiments as those in Year 1, but stated that senior lab is the best venue. One explanation is that the attorneys selected to assess the presentations in Year 2 had an engineering background, while those in the first did not. Student feedback, which was independent of the survey, revealed that the comments provided by the attorneys were substantive and supplemented the experience as a whole.

## Introduction

When most people hear that a course in “ethics” is being given, they often think that this will be an instruction in “goodness.” Moreover, they often believe that you cannot change a person’s behavior by providing examples of the correct way to do things. In the context of the chemical engineering profession, this is manifested in the AIChE Code of Ethics, which states that members “shall uphold and advance the integrity, honor, and dignity of the engineering profession...” [1] These Codes put forth by AIChE (and also NSPE [2]) stresses the duty and obligation of engineers to do what is morally right, sometimes over the needs of the organization. Because of the great responsibility held by practicing engineers, members of the academic community (including ABET) believe that the teaching of ethics should be incorporated into the undergraduate chemical engineering curriculum. Johnston et al assert that if an effort is not made to familiarize students with engineering ethics, then students are more than likely to enter into the work place completely oblivious and for the first time witness the reality of ethical dilemmas, which may go far beyond the exceptional technical skills of any engineer. [3]

The logistics of teaching ethics to engineers has always been an issue. Studies have shown that many engineering professors are more comfortable teaching quantitative concepts to their students compared to humanistic topics [4]. This is expected because math and logic is fundamental in engineering practice. Moreover, some professors are uncomfortable dealing with ethical dilemmas that do not have concrete solutions. Many feel that due to the ambiguity of these dilemmas, successful learning solely depends on how the students perceive the problem. Finally, professors often do not have the adequate time to introduce and proficiently cover the concept of professional ethics into the rigorous engineering curriculum. [5]

Although the suggestion of implementing ethics into the engineering curriculum sounds rewarding, the question of how to teach ethics to future engineers has become a major challenge. Several approaches have been suggested. A semester long engineering ethics course was initially considered. However, finding an engineering professor to teach the course was difficult. Additionally, many had the opinion that a full semester was too long to devote on a topic that was not highly technical. Thus, the compromise was to use case studies inserted in a course because they seem to be the most effective for teaching undergraduates [6]. First, case studies greatly mimic the ambiguity that would be seen in a workplace scenario. This provides students the necessary exposure to these open-ended problems, and allows them to develop the skills necessary to attaining a valid solution. Second, the controversial angle of many of these case studies provides a venue for intellectual discussion that elicits the difference of opinions. This not only helps student develop oral communication skills, but also the ability to formulate sound arguments. Finally, case studies relieve the professor as an authority figure, thus shifting them to the role of facilitator. This shift in focus allows professors who do not have a strong background in teaching ethics to easily generate discussion, yet provide context for students to learn.

## Methods

Engineering ethics was introduced for the first time into the chemical engineering curriculum at Manhattan College during the Spring of 2009 (Year 1), and repeated again during the Spring of 2010 (Year 2). The course in which it was introduced into was the second semester of senior level unit operations laboratory.

The concept of ethics was incorporated into a lecture during the middle of the semester for this course. It emphasized several concepts regarding ethics, such as the ideas of Utilitarian and Kantian ethics. In addition, the lecture also consisted of a discussion of popular engineering case studies involving ethical dilemmas among the students, such as the Challenger disaster.

The major aspect of integrating ethics into the chemical engineering curriculum was the use of the LITEE case study involving ethics within an engineering framework. The selected LITEE case study was the Lorn Manufacturing case study developed by Chet Plank [7]. This case describes an incident involving Jim Russell, a maintenance worker at WMS Clothing, who lost three of the fingers on his left hand during a routine maintenance procedure on a cotton manufacturing device called the Lap Winder. This occurred when the Lap Winder he was maintaining suddenly came on. He was suing Lorn Manufacturing Inc., the designers of the Lap Winder device used in the textile mill, for negligence. The ultimate question to be decided among the students of the unit operations laboratory course in this case is whether Jim Russell, the Lorn Textile Manufacturing, Inc., or WMS Clothing bears the responsibility for this particular injury.

This LITEE case was selected because it provides the student with several learning opportunities. First, it informs students of the basic skills that are necessary for professional engineers. These skills include an understanding of the codes and standards, the ability to ethically design equipment with technical accuracy, and most importantly, the ability to communicate highly technical issues in a simple yet comprehensible manner. Second, the Lorn Manufacturing case provides an example of how engineers play a major role in the legal system as expert witnesses. Finally, the case emphasizes the significance of safety awareness and responsibility in designing equipment, such as OSHA regulations for lock out/tag out procedures and limit switches [7].

For the LITEE case study assignment, the students were divided into five groups of four students each. The groups constituted of the Rapporteurs, Lorn Managers, Lorn Engineers, WMS Administrators, and WMS Maintenance Workers. Each group was responsible for presenting their argument through an oral presentation in front of a panel of attorneys. It is noteworthy to mention that the constituents of this panel were different over the two iterations of this study. The Rapporteurs were responsible of presenting the case facts followed by each of the major constituents in the order shown above. Each presentation was performed by three group members using Microsoft PowerPoint, and lasted for approximately ten minutes. After the final presentation, the groups were given 10 minutes to formulate any rebuttals, which were delivered by one representative from each group. This panel discussion, which was moderated by the Rapporteurs, was allowed to continue until the allotted time expired.

## Results

<b>TABLE 1: Student Responses on Ethics Survey</b>			
<b>STATEMENT</b>		<b>SCORE * YEAR 1</b>	<b>SCORE * YEAR 2</b>
1	It is important to study ethics in the context of an engineering program.	4.29	4.45
2	The education you have received prior to this assignment has helped you in resolving ethical issues.	3.65	3.98
3	Your previous engineering instructors have addressed the importance of ethics.	3.06	3.11
4	A case study approach was useful in learning engineering ethics.	3.88	4.27
5	Senior laboratory is the best course in the chemical engineering curriculum to insert this assignment.	2.35	4.08
6	This assignment has exposed you to new ethical concepts.	3.94	4.15
7	This assignment changed your attitude towards ethical dilemmas.	3.29	3.64
8	This assignment is an excellent tool in demonstrating the importance of engineering ethics.	4.06	4.22
9	Engineering ethics should be its own course.	3.53	4.12
10	I would have approached this assignment differently if I had an audience of my peers, rather than attorneys.	3.18	3.02
11	Ethics is a function of the way you were brought up.	3.88	3.96
12	It is possible to change one's ethical values after participating in this assignment.	3.06	3.26
<p><b>SCALE: 1 - STRONGLY DISAGREE, 2 - DISAGREE, 3 - NEITHER AGREE NOR DISAGREE, 4 - AGREE, 5 - STRONGLY AGREE</b></p> <p><i>* The scores are based on an average response of all students in a particular year.</i></p>			

Students in this course were instructed to complete an anonymous survey at the end of the semester evaluating the LITEE Lorn Manufacturing case study. They indicated their opinion on several statements associated with ethics on a five point Likert scale. For instance, a value of 1 showed that the student strongly disagreed with the statement, whereas a value of 5 showed that the student strongly agreed with the statement. These statements and the results are shown in *Table 1*.

Over the two years of the study, the majority of the students agreed that ethics should be taught in the engineering curriculum, and that a case study was a useful tool in doing so (i.e. Statements 1 and 4). Moreover, the results show that the case study used in the assignment helped students learn new concepts in ethics, as well as highlighted the importance of ethics in engineering (i.e. Statements 6 and 8). However, one significant difference in the responses between the two years is observed when asked about inserting ethics into senior lab (i.e. Statement 5). Students in the second year were more agreeable to this notion compared to those in the first. Although the implementation of the project was the same between the two years (along with the rest of the senior lab course), the major difference was the panel of attorneys used to evaluate the students. More specifically, their difference in background may have attributed to a more positive experience in Year 2. In Year 1, the attorneys had backgrounds in biology and electrical engineering. However, in Year 2, the panel had backgrounds in industrial and civil engineering, both with industrial experience, and the latter with a P.E. license. One student writes in the free response section of the survey, “The two attorneys offered excellent comments in relating real-world industrial experiences to this particular dilemma.” Another writes, “Our discussions with the attorneys drove home the importance of ethics in practice. Their past (and current) experiences were valuable in putting things into perspective.”

Because the use of attorneys with engineering backgrounds and industrial experience may not be easily directly implemented by others, the general conclusion for a successful outcome in this assignment is to choose the panel wisely. Anecdotally, the attorneys participating in Year 2 were more engaging and shared more of their experiences compared to those in Year 1. Thus, perhaps the best selection for panel members is to identify members of industry who may have had experienced several ethical dilemmas in their place of work.

Although the feedback after Year 2 was generally positive, the assignment still has some limitations. There was a tepid response when students were asked if the assignment changed their attitude towards ethical dilemmas, as well as its ability to change one’s ethical values (i.e. Statements 7 and 12). This relates to the broader question of whether ethics can be taught in class, or if it is a function of how the student was raised (Statement 11). Although the responses from the latter were not particularly strong (3.88 and 3.96 for Year 1 and Year 2 respectively), they suggest that a student’s upbringing plays a role in how they approach ethical dilemmas. Despite their seemingly hard-wired morals, assignments such as the one described in this paper may be beneficial by exposing students to situations they may encounter in practice, thus making them more confident and comfortable in addressing these types of dilemmas.

## Conclusions

This work describes the results of integrating an ethics case study in Senior Unit Operations Laboratory over a two year period. The data obtained from post course surveys revealed several findings. First, students feel that learning ethics is important, and that case studies were a useful tool in doing so. Second, we need to consider if teaching ethics is useful, because it is often a function of how students are raised. Finally, choosing the “right” personnel (i.e. one that is engaging and possesses a relevant industrial background) for this project is important for delivering a positive experience for students.

## References

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