Session Number

Teaching Engineering Ethics with *The Engineering Ethics Challenge* Game

William C. Carpenter
University of South Florida

1. Introduction

Most engineers will agree that students should develop a sound grasp of engineering ethics so as to be able to handle ethical situations that arise in the workplace. Indeed ABET [1], recognizing this need, has stipulated as a student outcome that graduates must have *an understanding of professional and ethical responsibility*. Thus, most engineering curriculums have either a course on engineering ethics or have the subject of engineering ethics distributed throughout the curriculum.

Engineering ethics is difficult to teach in a lecture format. A standard approach in a typical engineering ethics course is to review the code of ethics of several professional organizations and then to examine case studies in order to show students how to use the codes to support good engineering ethical decisions. Attitudinal change of students is a lengthy process. Students must learn to think like ethical engineers and, for some students, it takes a long time to learn to think in this way. Thus, a number of case studies have to be examined. Often, students find it boring to review the factual material in the codes and tend to lose interest after two or three case studies. Ideally, students are engaged in discussion of the cases considered to emphasize relevant points of the codes and to keep their interest. However, in a lecture format even a skilled professor may find it difficult to involve students in discussion and to hold their interest.

2. An Ideal Course

An ideal course format would be one which

- addresses engineering ethics in a way that keeps students involved and
- addresses the other ABET student outcomes which deal with communication skills and teamwork skills.

Lockheed Martin, in response to unsuccessful attempts at covering ethics material in a lecture mode, developed an interesting format for familiarizing their employees with the company's code of ethics. They developed a board game called *The Ethics Challenge*[2], which is similar to the popular game *Monopoly*. Employees, by playing this game, learn the material in the company's code of ethics without losing interest. In *The Ethics Challenge* game:

- The class is organized into groups. The groups draw an ethical question that has multiple-choice responses. The groups decide on their answer.
- The class moderator, as the *expert*, scores each multiple-choice response based on how well the response agrees with the company's code of ethics.
- The groups then move their pieces along *The Ethics Challenge* board based on the score that they received for their response.
- The groups then draw another ethical question and continue with the game. At the end of the game, the group that has moved the farthest along *The Ethics Challenge* board wins.

A depiction of the *Ethics Challenge* board is shown in Figure 1 by permission from the Lockheed Martin Corporation.

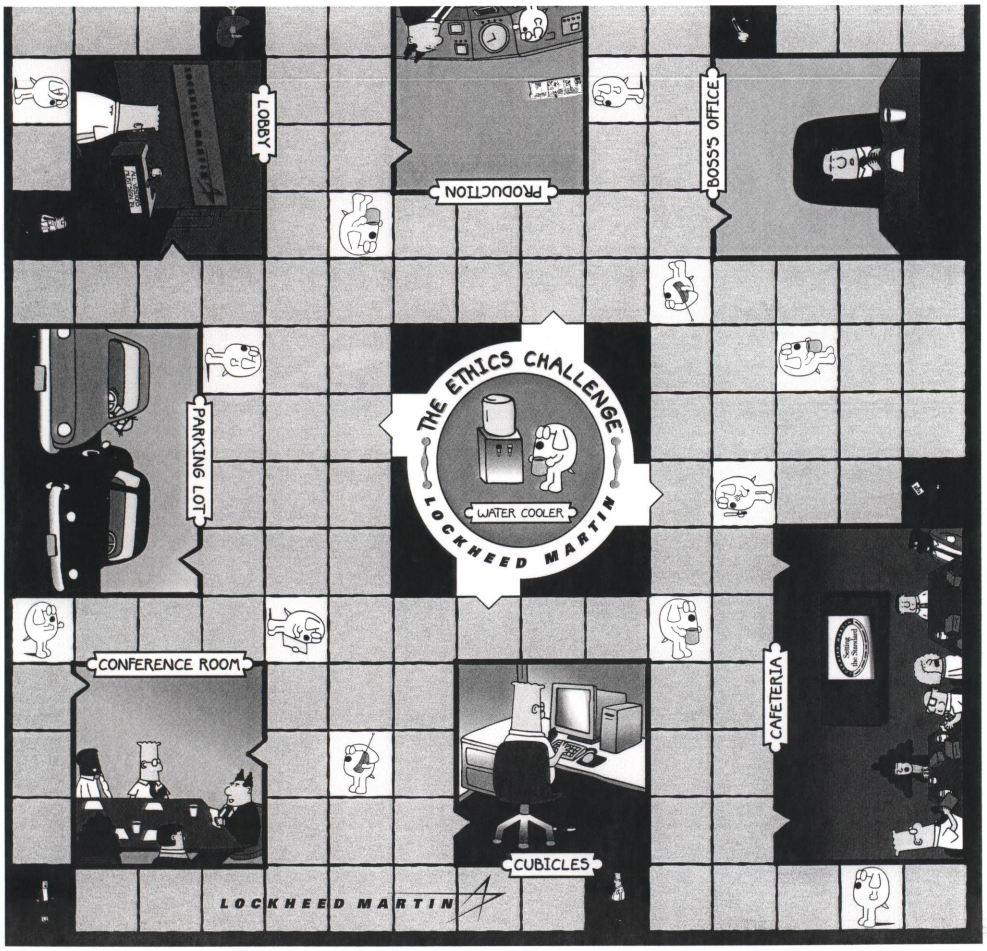


Figure 1. The *Ethics Challenge* board

3. The USF Approach

The Department of Civil and Environmental Engineering at the University of South Florida offers a course entitled *Professionalism and Ethics in Engineering*. This paper reports on the format for the course which was used in Semester II, 2003. The course was based on Lockheed Martin's *The Ethics Challenge* approach. However, the course involved much more student participation and better developed student ethical problem solving skills than would have been obtained by simply playing an ethics game. The format employed had the additional advantage that it helped develop students' teamwork and oral and written communication skills. The course centered around having students develop their own game, *The Engineering Ethics Challenge* (*EEC*) game, where questions were based on ethical situations found in texts (such as the text by Harris, Pritchard, and Rabins[3]) or from the ethical situations presented on websites (such as the website of the *National Institute for Engineering Ethics*[4]).

The structure of the course was:

- The class was divided into 6 groups with each group being assigned a name. In the spirit of the *Ethics Challenge* game, the 6 groups were assigned the names:
  - Boss
  - Catbert
  - Dilbert
  - Wally
  - Alice
  - Ratbert
- Groups developed *EEC* questions based on their assigned ethical situations and developed multiple-choice responses for each question. They developed a PowerPoint presentation of their questions and responses.
- The first group presented to the class a question with possible responses. The groups playing the game (those not making the presentation) discussed the question and choose an answer.
- The presenting group then gave the *expert* scoring for each of the multiple-choice responses. The best answer received a score of 5. The worst answer received 0. Other answers received a score from 1 to 4. Ideally, groups playing the game disagreed with the *experts* and there was a discussion of the *right* answer. The presenting group received a score of 5.
- The professor then critiqued the presenting group's performance as to the clarity of their question and responses, their understanding of the codes of ethics, their PowerPoint slides, and their oral communication skills.
- The groups playing the game then made their move on *The Ethics Challenge* board and the next group made its presentation.
- At the end of the course, the group, which has advanced the farthest along *The Ethics Challenge* board, won.

So that the reader can better understand the course, a typical group activity from the course *Professionalism and Ethics in Engineering* is presented next.

4. Typical Group Activity from the course Professionalism and Ethics in Engineering

This example concerns the Catbert group and myself as course Professor in the 2003 course offering of *Professionalism and Ethics in Engineering*.

- The Catbert group was assigned *Case 47, Unlicensed Engineer* from *Engineering Ethics*, Harris, Pritchard, and Rabins[3]. A brief synopsis of this case follows:

  > Synopsis of *Unlicensed Engineer*: Henry Wilson and Charles Landers were partners in the firm *Construction Engineers*. The firm designed and constructed septic systems. Henry Wilson was a registered Profession Engineer but Charles Landers was not. When Henry Wilson was out of the office and without his knowledge, Charles Landers on 40 separate occasions used Henry Wilson's P.E. seal to certify to the Anchorage city health department that septic systems that *Construction Engineers* designed and built met city wastewater disposal regulations. Subsequent investigations showed that all the designs did meet city standard. This case came to trial. Case 47 describes the attorneys' arguments and the judge's ruling.

- The Catbert group developed a question with possible responses for the *Engineering Ethics Challenge* game. The group made a PowerPoint presentation to the other 5 groups. Figure 2 shows the question presented by the Catbert group.

- The groups playing the *Engineering Ethics Challenge* game then discussed the question and decided on a response.

- The Professor called upon the groups in turn to give their response together with the rational for that response.

- After all groups had given a response, the Professor called upon the Catbert group to give its *expert* opinion. Figure 3 gives the Catbert group's *expert* opinion on the possible responses.

- The Professor then critiqued the Catbert group's work. Here the main criticism was that the Catbert group did not give specific references to articles in the *NSPE* and the *ASCE* Codes of Ethics as they were instructed.

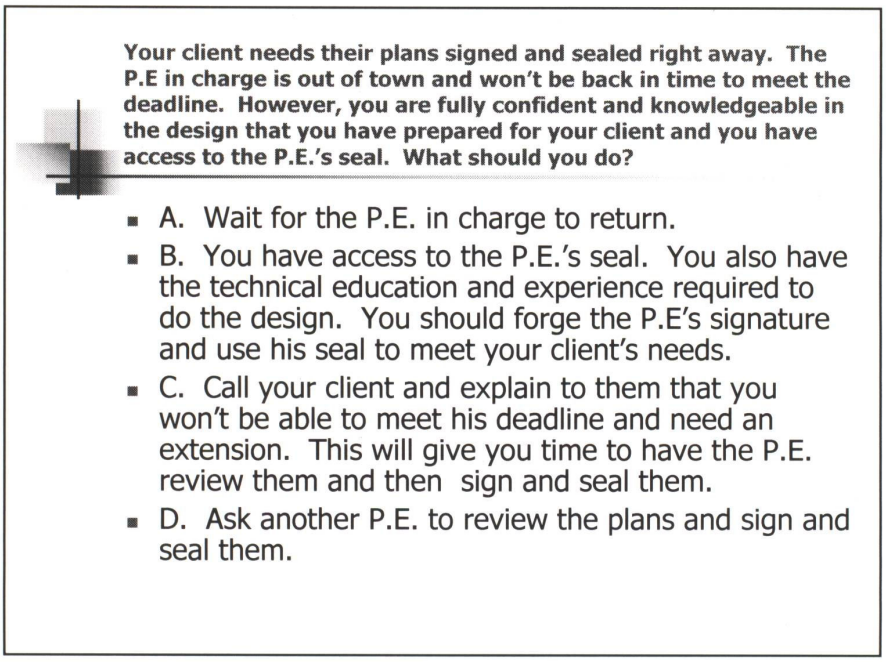


Figure 2. Ethical Question from the Catbert Group

5. Other Aspects of the Course

While the main topic of this paper is concerned with teaching engineering ethics through the *Engineering Ethics Challenge Game*, there are other aspects of the 2003 offering of *Professionalism and Ethics in Engineering* that are worth mentioning.

To familiarize students with various aspects of professionalism and ethics, a number of guest speakers were invited to talk to the class. Talks that were presented are listed below (the numbers in parenthesis were the number of 75 minute class periods allocated to the topic):

- Professional Regulation (1)
- Marketing Professional Services (2)
- Project Management (2)
- Company Organizational Structure (2)
- Total Quality Management (1)
- Legal Aspects of Engineering (1)
- Ethics in Transportation (1)
- Contract Law (2)
- Construction Management (3)
- Elements of Moral Philosophy (2)

All of the speakers but one were professional engineers who donated their time to prepare and give their talks. The Professor of Philosophy who talked on the Elements of Moral Philosophy was given a small honorarium.

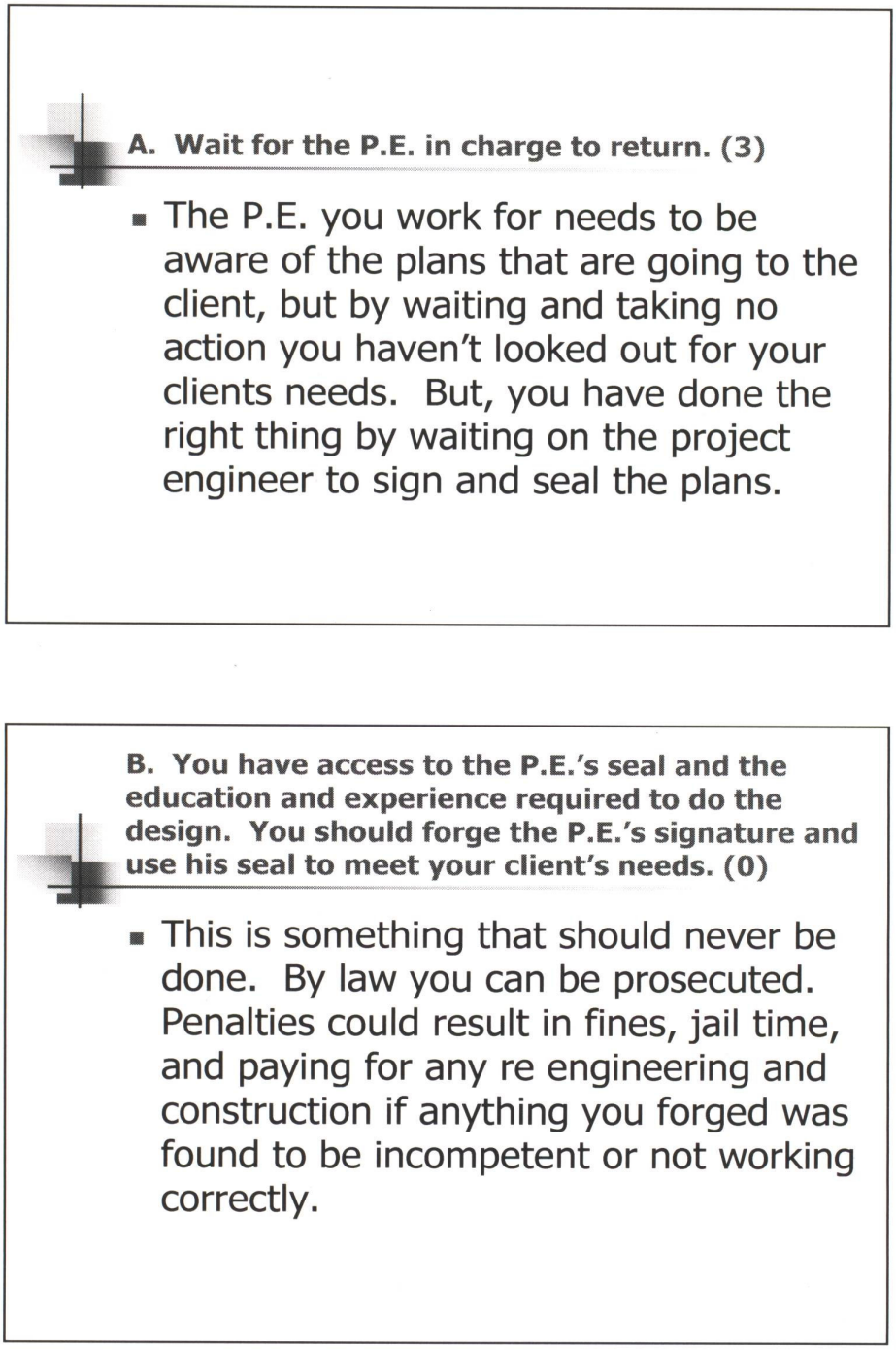


Figure 3. Expert Opinion by the Catbert Group (First Half of the Figure)

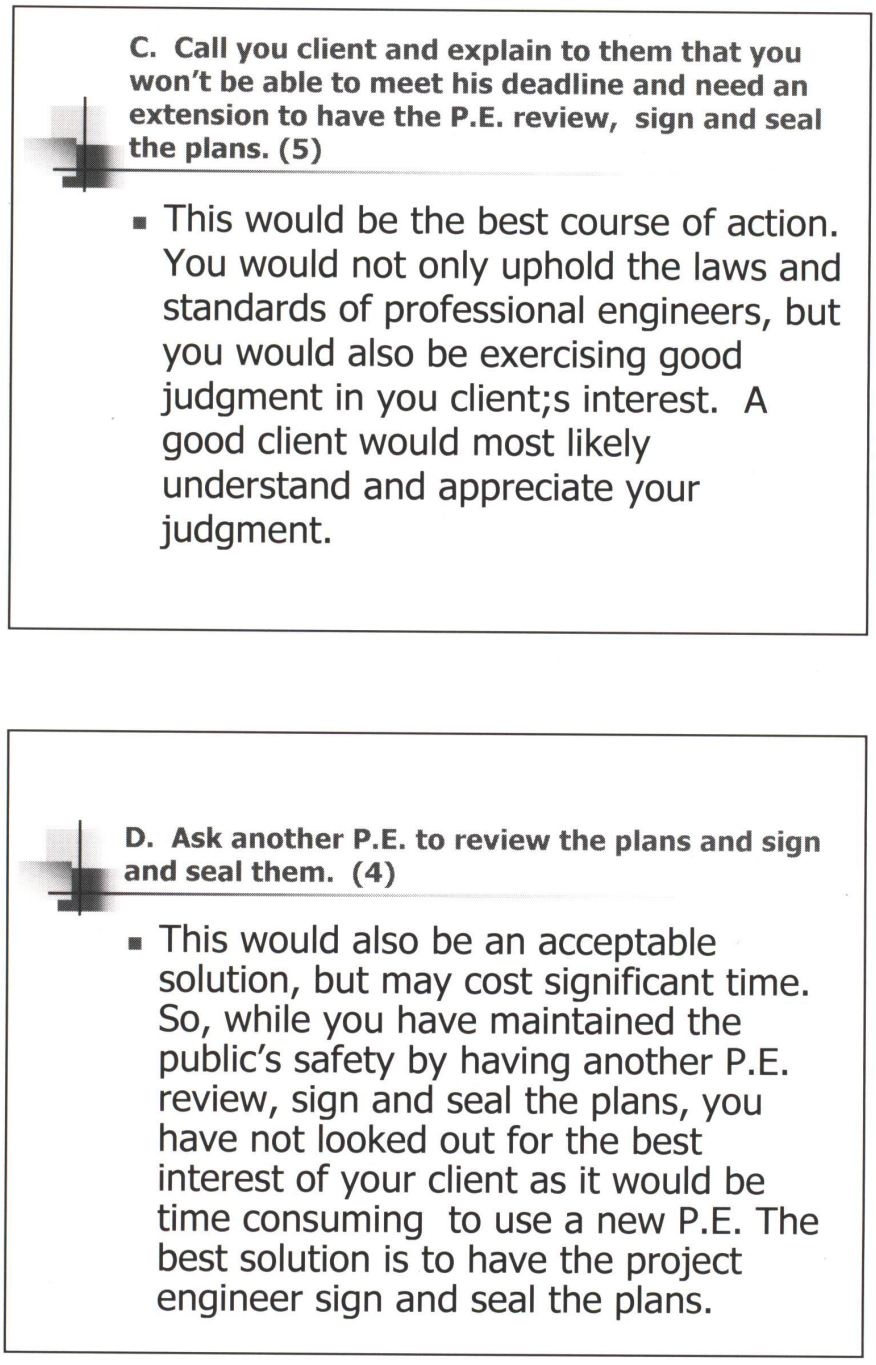


Figure 3. Expert Opinion by the Catbert Group (Second Half of Figure)

In the weeks when the class had guest speakers, the groups appointed a group secretary. Each secretary of the week took notes for the group outlining the talks given during that week and distributed the notes to the other group members. Each secretary of the week also composed a letter from the group thanking the speaker for his/her presentation. These activities helped the group members develop organizational and teamwork skills and helped them to learn professional courtesy.

Also, each group was called upon to develop and give a PowerPoint presentation to the class on some aspect of engineering ethics. In this way, the course helped to develop students' teamwork, organizational, and oral presentation skills. The group presentations in the 2003 offering of *Professionalism and Ethics in Engineering* were:

- Engineering Responsibility
- Honest, Integrity, and Reliability in Engineering
- Risk, Safety, and Liability in Engineering
- Engineers as Employees
- Engineers and the Environment
- International Engineering Professionalism

6. Course Assessment

For the course *Professionalism and Ethics in Engineering*, course assessment by the students and student assessment by the Professor are next discussed.

Course Assessment by the Students

Throughout the semester, students continually assessed the course by responding to questionnaires and writing memos on various topics. Selected data from this assessment is next presented.

One questionnaire was concerned with group presentations when groups covered aspects of engineering ethics and played the *Engineering Ethics Challenge Game*. Questions and responses to this questionnaire are given in Table 1.

Table 1: Student responses in a course assessment questionnaire

Question	Number responding yes	Number responding no
Should group presentations be a part of the course?	22	7
Did you learn as much as you wanted from the other groups' presentations?	17	11
Should the course professor cover the material that the student groups presented instead of the groups presenting it?	6	22

Students evaluated each of the guest speakers in another questionnaire: Decisions on what topics to cover, time allocated to each topic, and which speakers to use in the next class offerings of the course were based on these student evaluations. The questions asked about the speakers were:

- Did you think the speaker's topic was appropriate for this class?
  Definitely keep the topic
  Keep it for now but look for something better to offer
  Definitely get rid of this topic

- Was the speaker's coverage appropriate?
  More coverage (how may sessions)
  Keep the same
  Less coverage (how many sessions)

- Did you think this speaker/topic will have an impact on your life/career?
  Definitely
  Probably yes
  Perhaps but it is hard to say
  Probably no
  Definitely no

The mix of professionalism and ethics in the course was about 50/50%. A questionnaire at the end of the course asked students to evaluate this mix. Students' responses are tabulated in Table 2.

Table 2. Student response on the mix of professionalism and ethics in the course *Professionalism and Ethics in Engineering*

Question	Percent agreeing
Provide more on Professionalism	7%
Provide more on Ethics	10%
Leave mix about the same	83%

It was not clear to the Department whether the course *Professionalism and Ethics in Engineering* should be continued or abandoned in favor of an ethics throughout the curriculum approach. Near the end of the course students were asked to address this issue in a memo to the instructor. Most students were in favor of keeping the course (78% for keeping the course, 22% for not). Sample memos (retyped in a condensed format with the author's name deleted) are presented in Figure 4.

MEMO 4/2/2003

TO: William Carpenter, P.E., Ph.D

SUBJECT: What I think about the Professional and Ethical Issues in Engineering Class. Should Professional and Ethical Issues in Engineering course be taken out of the Civil Engineering curriculum?

Professional and Ethical Issues in Engineering is a course that should be taught in every school around the world. Knowing and learning the moral philosophy, engineering ethics and how to build professional engineers is needed these days. This course is a good way to understand the real life after college and how ethics helps and deals with engineers everyday. This course is an introduction for the students and will help them later how to conduct themselves when they face an ethical issue in engineering if they were working. Knowing the codes of ethics in Engineering and understanding what they are stands for will develop a real professional engineers. Professional and Ethical Issues in Engineering course makes the students to have a good foundation to function out in the real world as engineers. Taking out the Professional and Ethical Issues in Engineering course is like taking out the soul of an engineer and leaving his body judging himself. So Codes of ethics must be taught all times to build up a professional engineers of the future.

MEMO 3/21/2003

TO: William Carpenter

RE: Professional and Ethical Issues in Engineering. Should we have this course and why?

It is my opinion that the topics of Ethics and Professionalism in Engineering should be covered as part of the curriculum. There are several important topics that have been covered in our current class which are important for graduating engineers to have exposure to. The most important of these being: the codes of ethics, some exposure to the types of situations an engineer might be confronted with (i.e. case studies), and legal and disciplinary consequences of ones actions. I do feel, however, that the current course has, at times, been a waste of time. Perhaps exposure to the codes of ethics and legal/disciplinary issues should be part of the Intro To engineering course. A seminar on ethical case studies could be offered once per spring/fall semesters and students would be required to attend one of these and take proof of completion to their advisors prior to graduation. I also feel that the lecture by Mel Anderson regarding the examinations (PE., etc.) should be given during the intro to engineering course as well. The information from this lecture should be provided to all aspiring engineering students early on in their academic career.

Figure 4. Sample student assessment memos

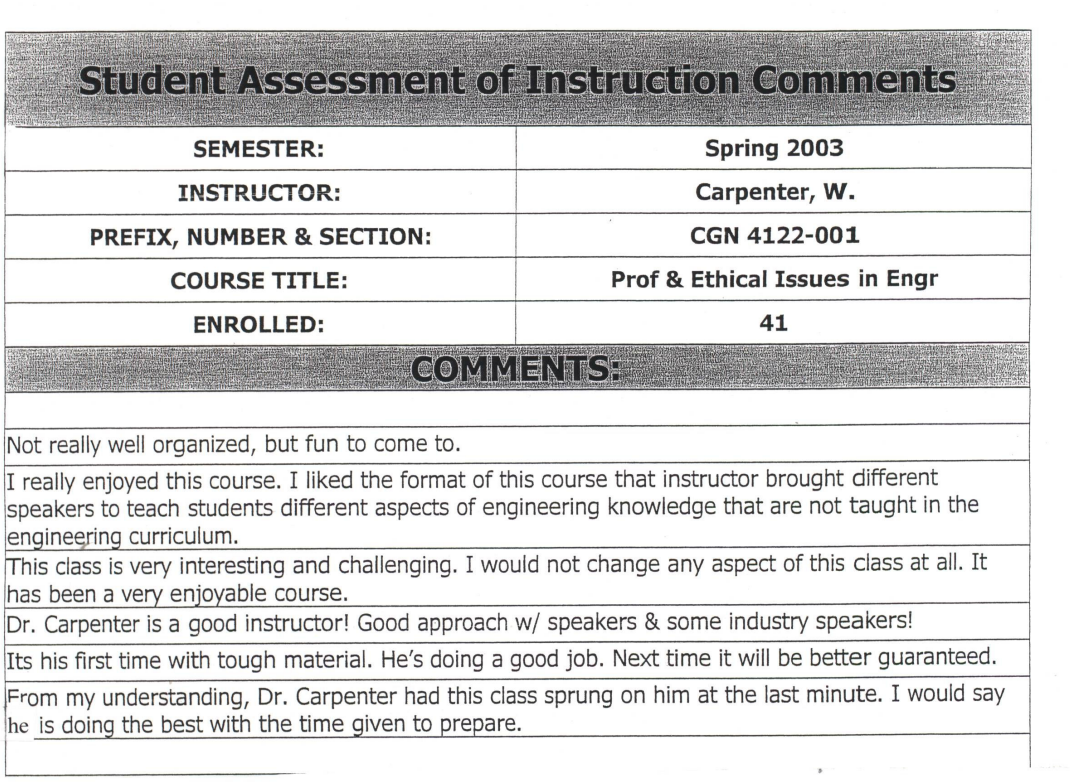
As part of the University's mandated assessment program, students evaluated at the end of the semester, both the course and the instructor. Topics were scored as poor (1), fair (2), good (3), very good (4), or excellent (5). Average student ratings of the relevant parts of this evaluation are given in Table 3.

Table 3. Annual student evaluation of *Professionalism and Ethics in Engineering*

Question	Average Student Response
Stimulation of interest in course	3.85
Facilitation of learning	4.08
Overall rating of Instructor	4.31

These rating are, of course, instructor dependent. However, they suggest that the format for the course is a good approach for presenting ethical material.

On the end of semester evaluation, students can give comments if they choose. The University's administrative staff type student comments and the typed comments are given to the instructor. Figure 5 is a copy of all the student comments. Student comments seem to indicate that the approached used in the course work well.



Student Assessment of Instruction Comments

SEMESTER:	**Spring 2003**
INSTRUCTOR:	**Carpenter, W.**
PREFIX, NUMBER & SECTION:	**CGN 4122-001**
COURSE TITLE:	**Prof & Ethical Issues in Engr**
ENROLLED:	**41**

COMMENTS:

Not really well organized, but fun to come to.

I really enjoyed this course. I liked the format of this course that instructor brought different speakers to teach students different aspects of engineering knowledge that are not taught in the engineering curriculum.

This class is very interesting and challenging. I would not change any aspect of this class at all. It has been a very enjoyable course.

Dr. Carpenter is a good instructor! Good approach w/ speakers & some industry speakers!

Its his first time with tough material. He's doing a good job. Next time it will be better guaranteed.

From my understanding, Dr. Carpenter had this class sprung on him at the last minute. I would say he is doing the best with the time given to prepare.

Figure 5. Student comments on the end of semester Student Evaluation

These assessments indicate that most students feel that there should be a course in Professionalism and Ethics and that there should be a lot of student involvement in the course. The Ethic Challenge game is one way of obtaining that involvement. Student numerical ratings of the course and student comments indicate that the *Engineering Ethics Challenge Game* approach coupled with lots of other student involvement can be a good approach to take.

Student Assessment by the Professor

Course grades were assigned to each student based on individual and group work. With the exception of a final individual paper that was assigned in lieu of a course final, students worked mainly in groups and groups were given a grade for their work. All group members received, as individual grades for their group work, the value of the group's grade except for those group members who were not contributing to the group effort. At the end of the course, each class member had to evaluate, in a confidential memo to the Professor, the level of participation of the other group members. Individuals who were singled out in this evaluation as not contributing to group activities were given a grade on their group work reduced from the group's grade. In the 2003 offering of *Professionalism and Ethics in Engineering*, only two students were found not to be fully contributing group members.

7. Summary

The advantage of using the *Engineering Ethics Challenge* Game format in an engineering ethics course is that a large number of ethics cases can be examined without students loosing interest. While playing the *Engineering Ethics Challenge* (*ECC*) game, students become familiar with the engineering codes of ethics and strengthen their ethical problem solving skills by developing questions and responses related to ethical issues. By working in groups, students develop teamwork skills. They also develop better communication skills through writing questions and responses for the *ECC* game, preparing PowerPoint presentations, writing memos, and giving oral presentations.

Bibliographic Information

1 *ABET Engineering Criteria 2000*. Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology, Baltimore, Md. (1995).

2 *The Ethics Challenge*, Lockheed Martin Corporation, Office of Ethics and Business Conduct, 310 North Westlake Blvd., Suite 200, Westlake, Village, CA 91362 (1997).

3 Harris, C.E., Pritchard, M.S., and M.J. Rabins, *Engineering Ethics: Concepts and Cases 2nd ed*., Wadsworth, Belmont, California (2000).

4 National Institute for Engineering Ethics website: http://www.niee.org/case-of-the-month/index.htm

Biographical Information

WILLIAM CARPENTER is a Professor of Civil Engineering at the University of South Florida. He received his B.S. and Ph.D. from North Carolina State University, has 6 years of industrial experience with Boeing and consulting engineering companies, and has been affiliated with several universities in the U.S. and Europe. The insights for this paper came from teaching *Professionalism and Ethics in Engineering* in Semester II, 2003.