Ethics Exercises for Civil, Environmental, and Geological Engineers

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ABSTRACT

The practices of civil, environmental, and geological engineering share many common ethical dilemmas. These fields typically require extensive interaction with clients and regulatory agencies, while dealing with unpredictable earth materials for design and uncertain design parameters. Consequently, a capstone design course must address not only technical issues, but also a wide range of ethical and behavioral issues. This study presents a series of exercises used in the classroom to teach these issues through dealing with “gray” ethical areas, concepts of advocacy and the use of compromise, relating specific stories to global concepts, proper behavior in the corporate environment, and the influence of corporate culture on ethical decisions. The exercises were designed to incorporate a variety of active learning styles, including individual and group writing, group short answer, group design, and role playing as an individual and as part of a team. Only a small commitment of class time is required to complete these exercises, roughly six lecture periods and one laboratory period.

I. INTRODUCTION

As part of the senior design curriculum, the Accreditation Board for Engineering and Technology (ABET) Engineering Criteria 20001 requires that graduates demonstrate an understanding of “professional and ethical responsibility.” This is particularly important in the fields of “earth” engineering, such as civil, environmental, and geological engineering, because our students typically will work in situations that require rigorous honesty and forthrightness. For instance, they frequently must track their own work hours for billing to a project. Often, they work under the oversight of a regulating agency whose staff do not have full knowledge of the site and must rely on these professionals to keep them informed. Example projects might include hazardous waste investigations under the oversight of a state or federal regulating agency, or geotechnical projects under the oversight of a local department of public works. Furthermore, in today’s litigious atmosphere liability considerations drive much of a professional’s behavior in the consulting engineering industry. It is our belief that we can best prepare our students for practice by having them face many of the future issues and pressures during their senior design project.

The goals of the ethics exercises are:
1. to reinforce the concept that engineers are frequently involved in judgmental decisions with no clear right or wrong answer,
2. to encourage the students to think through the judgmental and ethical decisions they will face before they have to deal with them in the working world, and
3. to help them reach a consensus about the underlying principles which guide each ethical decision.

II. LEARNING STYLES

A variety of learning styles is incorporated in the exercises because many of the ethical concepts are subtle, and students may not fully grasp them immediately. The approaches used in the exercises include lecture, individual and group writing, group discussion, group design, and role playing as an individual and as part of a team. The variety of approaches also makes the class more interesting and encourages students to develop a variety of communication skills in their responses. Table 1 summarizes the learning styles used in each of the ethics exercises.

The exercises also focus on active learning, as shown on figure 1. Not all of the exercises correspond to categories in Dale’s Cone of Learning, but nearly all those that do use teaching methods which have high retention. Similarly, most of the ethics exercises meet criteria as higher order educational objectives as defined by Bloom and shown on figure 2.

III. EXAMPLES OF EXERCISES

Recognizing that each engineering field must emphasize appropriate ethical dilemmas, the exercises presented below are examples which the reader should modify to suit one’s field. Many (but not all) of these exercises come from my experience. The reader is encouraged to draw examples from experience, because these examples will lend an air of realism to an otherwise hypothetical discussion, and the reader will better be able to describe the emotional and moral tension of the case.

Exercises below are grouped by ethical topic. A precis of the principle to be learned is presented in the table summarizing each exercise.

A. Billing

1) Exercise 1—Billing: In this exercise, students are given questions related to billing time and expenses. They are asked to discuss possible responses in groups of three or four, to identify the
underlying principle guiding their decisions, and then to suggest “the answer.” Because the responses are developed by the group, each individual feels protected within the group during the discussion time. I found that after a few hesitant volunteers, the students are comfortable with this format and readily volunteer their answers and comment on each other’s answers. An alternative would be to use individual role playing for a few of the questions, where one student plays the professional, one plays the irate client, one plays the “by-the-book” project manager, and so on.

While the discussion below outlines a number of ethical principles that should come out of the class dialogue, two overarching issues should remain central to the responses to each question:

- always give the client the benefit of the doubt (roughly, “always round in the client’s favor”), and
- be as forthright with your clients and supervisors as possible (avoid hidden agendas).

**Question 1.** The budget for a large project is subdivided into task accounts. The report preparation task has $38,000, but you’ve only spent $32,000. What are your options with the $6,000 and what do you do?

**Discussion 1.** The black and white options are either to leave the money unspent, or, unethically, to pad your billing report for an additional $6000. The goal of this exercise is to discuss the ethics of a third option, that of shifting the funds to another task that may be

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### Table 1. Learning styles of ethics exercises.

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Lecture and Discussion</th>
<th>Individual Writing</th>
<th>Group Writing</th>
<th>Group Discussion</th>
<th>Group Design</th>
<th>Individual Role Playing</th>
<th>Team Role Playing</th>
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<tr>
<td>Billing (Exercise 1)</td>
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<td>Bad news (Exercise 2)</td>
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<td>Written Opinions (Exercise 3, Table 2)</td>
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<td>Misinterpretation (Exercise 4)</td>
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<td>Relating to Your Employer – Time Off (Exercise 5, Table 3)</td>
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<td>Relating to Your Employer – Desirable Traits (Exercise 6)</td>
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<td>Public Meeting (Exercise 7, Table 4)</td>
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<td>Sixty-Seven Professional Practice Rules (Exercise 8, Table 5)</td>
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<td>Ethics Policy Statement (Exercise 9)</td>
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### Figure 1. Correlation of ethics exercises to Dale’s learning modes.

- 10% Reading
- 20% Hearing Words
- 30% Looking at Pictures
- 50% Watching a Movie
- 70% Looking at an Exhibit
- 70% Watching a Demonstration
- 70% Seeing It Done on Location
- 70% Participating in a Discussion
- 70% Giving a Talk
- 90% Doing a Dramatic Presentation
- 90% Simulating the Real Experience
- 90% Doing the Real Thing

### Figure 2. Correlation of ethics exercises to their respective Bloom's educational objectives.

- **1. Knowledge**
  - List, recite

- **2. Comprehension**
  - Explain, paraphrase

- **3. Application**
  - Calculate, solve, determine, apply

- **4. Analysis**
  - Compare, contrast, classify, categorize, derive, model

- **5. Synthesis**
  - Create, invent, predict, construct, design, imagine, improve, produce, propose

- **6. Evaluation**
  - Judge, select, decide, critique, justify, verify, debate, assess, recommend, argue
over-budget. Discussion should bring out two points. First, the ability to move funds between tasks depends somewhat on the billing arrangement for the project (lump sum, time and materials, etc.). The project budget is morally and legally binding but the subdivision into task accounts is usually a matter of convenience. Second, the client should be made fully aware of what you intend to do and why.

Question 2. A situation similar to the previous example, but you’ve spent $45,000. What are your options and what action should you take?

Discussion 2. In this case, students may identify only the option of informing their client of the overrun and accepting the consequence, which is to lose the $7000 overrun. This scenario should initiate discussion on the benefits of maintaining close and timely communication with your client, so that an impending cost overrun is not a surprise. Furthermore, discussion may lead to cases when such an overrun may be justified, such as a scope increase requested by the client.

Question 3. Your company bills to the nearest 1/2 hour. How much do you bill if you worked 10 minutes? 15 minutes? 20 minutes? 25 minutes?

Discussion 3. It is inappropriate to bill more time than you worked. The “black and white” options are to bill the 1/2 hour only when 30 minutes have been worked, or to round upward and bill 1/2 hour when 16 minutes have been worked. Discussion should center on the gray area of “banking” time for a day or two until 30 minutes have been committed to the project. The intent is not to be legalistic, but to give the client the benefit of the doubt. How much time is a reasonable span to bank hours? Beware of the following “lawyer mentality”: “Dear client, thought I saw you on the street the other day, crossed over to say hello, but it wasn’t you, so I went back. One-tenth of an hour: $25.00.”

Question 4. In order to be at a project site for an 8 a.m. meeting on Monday, you must fly out Sunday night. Do you charge the flight time?

Discussion 4. Discussion should lead to the principle that an engineer already has a “base” commute time from home to office and a “base” commute week, usually Monday through Friday. Travel in excess of these base values is justifiably charged to a project. To be fair to the client, travel less than the base commute, such as the short drive from the motel to the site, should be considered “credit” time for the project. Again, it is beneficial to discuss this with a client should there be any doubt.

Question 5. For a six-week drilling project in Tucson, who pays for your sunscreen?

Discussion 5. Companies typically pay for non-standard health and safety equipment such as chemical resistant suits, air purifying respirators, etc. They may or may not pay for standard, yet required, equipment such as protective gloves, steel-toed boots, or hard-hats. Discussion should lead to the distinction between “comfort” items vs. health and safety items, and the distinction between required items vs. optional items.

Question 6. You have $40/day in your per diem budget for meals. You happen to mention to the client that you had dinner at a local nice restaurant for $28 and she hits the roof. How do you respond?

Discussion 6. Strictly speaking, the $40 could be parcelled anyway the engineer sees fit, unless the per diem budget specifies a ceiling amount per meal. Again, strictly speaking, the company and the client have both recognized this by agreeing to the per diem amount in their contract. In essence, work away from home is a hardship and per diem is an acceptable form of compensation. Students should be led to recognize that the real issue is not the appropriateness of the charge but how the engineer responds to the client.

B. Client Relations

For these exercises, students are faced with a variety of challenging client relations problems, when they must not only salvage the client’s trust, but also maintain their professional integrity. Three groups of exercises are given.

1) Exercise 2—Bad News: This exercise deals with an engineer’s relationship with the client during stressful periods, such as times when bad news must be conveyed. The questions may be answered in the same ways as the billing exercises, using group discussion and answer or short role playing techniques. The principles introduced in this set of questions are:

- you are expected to make small decisions on your own and get help with larger decisions,
- your professional responsibility may extend beyond the project at hand,
- open, timely communication with the client or your supervisors may avert problems before they arise, and
- sometimes solutions which benefit everyone can be found for mistakes or undesirable findings, a “win-win” result.

Question 1. You are monitoring drilling of pier holes for a deep foundation (100 feet). You notice that the water draining from the muck has an oily sheen, smells strongly of hydrocarbons, and has stained the soil black. What do you do?

Discussion 1. This scenario lends itself to two undesirable options: ignoring the contamination, and thereby neglecting professional responsibility, or stopping work on the project indefinitely, a monumental action for a young engineer. The main point of the vignette is that field workers and new employees are not expected to solve these problems alone: they should stop work temporarily and call the office. New professionals should have the maturity to make most decisions without deferring to their supervisor. They should also be able to identify tentative decisions which require more senior input.

Question 2. You have been hired to investigate a landslide at a housing project. While the client is driving you across the site to the landslide, you notice that the construction company’s laborers are installing utilities inside an un-shored trench 8 feet deep. What do you do?

Discussion 2. This scenario is similar to the previous “whistleblower” scenario in Question 1, with two differences. First, the problem noticed by the engineer does not directly relate to the project, and second, the problem noticed will not prevent the landslide investigation from proceeding. Students should recognize that as a professional who has seen an illegal or imprudent practice in one’s profession, they are duty-bound to see that the practice is corrected. Indeed, they may even be legally responsible, depending on the violation. The most straightforward solution is to explain to the client that as an engineer who has observed such a practice, you could incur legal responsibility. Therefore, you ask the client to have the workers exit the trench until it is shored or benched.

Question 3. Your company has been asked to recommend one of three potential sites for a landfill location. All three sites have significant problems. Options?

Discussion 3. The implication in this scenario is that the client has selected the three sites and has asked you for a ranking. The best approach to this problem is to communicate your impression before you have spent the client’s money preparing a report. Timely
communication may allow the client to select other sites and to request your input to avoid the problems faced by the first three sites.

*Question 4.* Out of 100 site wells, you were to sample 15 specific ones for chemical analysis. Unfortunately, five of the wells you sampled were not on the list of 15. Under what conditions should the client pay for sampling the omitted wells?

*Discussion 4.* The client should pay for the extra sampling only if they misled you in selecting wells for sampling. If all site wells are on a specified sampling schedule, it may be possible to arrange with the client and any oversight agencies to substitute one or all of the wrong wells into the current sampling list, and sample the five omitted wells when the wrong wells should have been sampled. Even though a mistake has been made and it was your fault, this does not mean that you or the client necessarily must lose money.

*Question 5.* You budgeted five days of drilling for 10 exploratory borings. The work begins early Monday morning, but by Friday, you have

<table>
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<tr>
<th>Exercise</th>
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<tr>
<td>1. Your report concludes with the following statements:</td>
<td>Your conclusions identify “possible” contamination from ground water from offsite sources or from past agricultural uses of the site.</td>
</tr>
<tr>
<td>Based on the information reviewed during this investigation, it is possible that the subject property has been environmentally impaired by the presence, use, storage, handling, and disposal practices involving hazardous substances.</td>
<td>Your client would prefer to focus on the “lack of evidence” of contamination rather than the “possibility” or contamination.</td>
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<td>Assuming the groundwater flow direction of west-southwest, HL Trucking Company, A&amp;K Cable Company and Hummel Company may have contaminated groundwater which flows beneath the subject site. Because of local variations in groundwater flow direction, it is also possible that contaminated groundwater from the Midway and Nationwide Window properties has reached the subject site.</td>
<td>The client’s most likely argument is that your conclusions imply contamination where none was actually found. Your argument is that none was found because no investigation has been done.</td>
</tr>
<tr>
<td>The data reviewed during the initial site overview suggests that the site may have been used for agricultural purposes in the past. Consequently, there is a potential threat of pesticides to human health and the environment at the site.</td>
<td>In group discussion, students should be able to conclude that the compromise statement should make it clear that no contamination has been found to date, but that offsite sources or past site uses may have impacted soil or ground water.</td>
</tr>
<tr>
<td><strong>The client wants to change it to:</strong></td>
<td>A possible compromise statement might be:</td>
</tr>
<tr>
<td>There is no evidence that hazardous substance practices at the site have impacted the soil or groundwater and we recommend no further investigation.</td>
<td>Based on the information reviewed during this investigation, there is no evidence that hazardous substance practices at the site have impacted the soil or groundwater.</td>
</tr>
<tr>
<td>There is no evidence that environmentally impaired groundwater from nearby sites has impacted the subject site. These nearby sites are already under investigation by regulatory agencies, so we recommend no further investigation at the subject site.</td>
<td>Assuming the groundwater flow direction of west-southwest, HL Trucking Company, A&amp;K Cable Company and Hummel Company may have contaminated groundwater which flows beneath the subject site. Because of local variations in groundwater flow direction, it is also possible that contaminated groundwater from the Midway and Nationwide Window properties has reached the subject site. To date, there is no evidence that contaminated ground water from these sites has reached the subject site. Sampling of ground water near the upgradient site boundary could quickly confirm the presence of contaminated ground water from offsite.</td>
</tr>
<tr>
<td>Although the subject site was once used for agricultural purposes, it is currently developed (covered with concrete, asphalt, and buildings). Therefore, there is no potential for contact with residual agricultural chemicals and we recommend no further investigation.</td>
<td>Although the subject site was once used for agricultural purposes, it is currently developed (covered with concrete, asphalt, and buildings). Therefore, there is a low potential for contact with residual agricultural chemicals.</td>
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</table>

*Table 2.* Exercise on written opinions (Exercise 3).
only finished 8 borings. Under what conditions should the client pay for another day or two of drilling?

**Discussion 5.** While the solution to this problem may hinge on the specific contracts between you and your client and the drilling subcontractor, two principles should arise in discussion. First, the client should be aware of the possible time overrun early in the week. Second, weather and unexpected subsurface conditions could cause valid time overruns, an acceptable, although undesirable, charge to the client.

2) **Exercise 3:** This exercise is summarized in table 2 and asks students to work in groups of three or four to rewrite a short conclusion section to a report. The rewrite is to be a compromise between their original statement and the client’s “wish list” statement. The rewrite should be sensitive to the client’s underlying focus, without sacrificing the professional integrity of the engineer. While many students at the senior design level may understand the concept of professional integrity in writing, they may not recognize the amount of leeway available to meet their client’s needs. This exercise naturally proves to be a lesson in “weasel words,” but it will reinforce to students the subtleties in language that can help avoid misinterpretation of their writing or even avoid legal liability.

3) **Exercise 4:** When these exercises are used as part of a design class, students are anxious to convert their technical knowledge into a useful product. Exercise 4 allows them to do this in a group setting, while also focusing on improving the ethical behavior of the parties with whom they work. The exercise statement is as follows: “You are supervising a contractor hired by the client. You know that this contractor is trying to overcharge and skimp on work. Write a foolproof outline for monitoring fill selection and compaction control of a large fill area. You are worried about density, moisture, organic content, plasticity, and grain size.”

The goal of this exercise is to give students practice writing unambiguous and difficult-to-misinterpret documents. The exercise also gives students practice writing in a group setting. In the exercise, I encourage the students to treat their clients and subcontractors as if they were pure and honest, yet to write reports and document their work as if the clients and subcontractors were scheming and dishonest.

### C. Employer Relations

1) **Exercise 5:** In the first employer relations exercise, shown on table 3, students are split into groups of three. Each of the three is given a “part” to play, shown on the table. Students are encouraged to treat their clients and subcontractors as if they were pure and honest, yet to write reports and document their work as if the clients and subcontractors were scheming and dishonest.

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<tr>
<th>Exercise</th>
<th>Discussion</th>
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| 1. **EMPLOYEE**

You have just come off a six-week field project. You worked an average of 50 hours a week and thought you did a great job. In daily discussions with your project manager, he/she always seemed satisfied with what you were doing and rarely had any input. You are currently burnt out and would like to take three days off, with pay, as comp-time for your hard work. When you propose this to your project manager, he/she got visibly angry and said, “no.” You pleaded your case to no avail and now you are to meet with the project manager and the department manager to work it out.

| 2. **PROJECT MANAGER**

The employee has been on a field job for six weeks. He/she did not seem to work efficiently, so, in your view, too many hours were charged for the end product. The employee spoke to you daily, during which times you said a few words about hurrying to finish the job, but not much else because you didn’t want them dawdling on the phone. Now the employee wants three days comp-time, which you denied. He/she pressed the issue to the point that you called the department manager to back you up.

| 3. **DEPARTMENT MANAGER**

The employee is well-liked but inefficient. The project manager is uncommunicative. You are to find out the situation and work out a compromise. You are also to get the project manager and employee to agree on ways to prevent this sort of disagreement from happening in the future.

The employee sees nothing wrong with his or her performance on the project. However, even with just this short summary of the situation, students should recognize two things the employee should have done:

1. Communicate to the supervisor early in the project their intention to take time off at the end, and
2. Actively seek out constructive criticism on their performance.

It may be hard to fault the project manager for his or her reluctance to allow the time off. However, the project manager should have provided the employee with a timely assessment of his or her performance.

The neutral role of the department manager may be a new one to many students. They should recognize that in spite of this role, the department manager also bears some responsibility for the problem at hand. He or she should have been proactive in addressing the employee’s inefficiency (through the proper chain-of-command, of course) and in addressing the project manager’s poor communication skills.

Table 3. Exercise on relating to your employer (Exercise 5).
to be emotional and to fight (orally, of course) to win their case. The key to this exercise is that each player has a different perception of the situation. Through their role playing, they need to 1) communicate their perception, 2) understand the perceptions of the other players, 3) work out a solution, and 4) identify ways to avoid this problem in the future. The goals of this exercise are to simulate a tense discussion of a problem that can only be solved by compromise, and to reinforce the importance of open communication between fellow workers.

2) Exercise 6: This exercise is meant to follow a lecture or discussion on desirable professional qualities such as attitude, versatility, friendliness, and technical competence. The point of this exercise is to reinforce the idea that qualities other than technical skill are necessary for success in an engineering organization. The exercise also reinforces the importance of continuing education and preventing "technical obsolescence." This exercise lends itself to a group discussion format, as used on the billing and some of the client relations exercises. The text is:

"Your company must down-size. The good news is that your job is safe. The bad news is that you have been asked to prepare a list of characteristics of people who should be kept, and a list of characteristics of people who should be let go."

D. Advocacy

1) Exercise 7: One of the three design projects for the geological engineering design class involved assessment of a hazardous waste site. Students were provided with the data from a subsurface investigation, including soil and ground-water chemical tests, geology, and results of human health risk assessment. Their assignment was to interpret the data and prepare a report summarizing their conclusions, recommendations for further investigation, and recommendations for site cleanup.

Since the concept of advocacy is so important in the environmental field, and since this concept leads to ethical dilemmas, students were also asked to represent one of the involved parties in a simulated public meeting. The public meeting was a site-progress meeting,
where the engineering consultants for the project would have a chance to present their recommended cleanup method and receive comments from stakeholders.

Students were split into four groups, and each group received a confidential summary of their group's "hidden agenda" and goals for the meeting (table 4). The groups were:

1. Army—site owner and party responsible for cleanup of a base intended for closure,
2. Engineering Consultant—hired by the Army to provide technical expertise,
3. City of Sandville—municipality bordering the site, hoping to inherit part of the site following base closure, and
4. State Water Board—local regulating agency charged with ensuring that the cleanup plan is appropriate.

Groups were instructed that, as technical professionals and advocates for their organization, they were responsible for defending the agenda items on their confidential summaries. Their success in doing so was evaluated by the entire class during a lecture period after the public meeting.

The meeting started with a 20-minute technical presentation by the consultant, followed by five-minute presentations from each of the other parties. The floor was then opened for questions between parties. Next, the floor was opened for questions from the audience, which consisted of the geological engineering faculty and approximately 25 senior-level students.

The goal of this exercise was to provide students with an opportunity to be advocates for issues with which they may not necessarily agree. Their advocacy was further limited by their professional integrity, and the public meeting format prevented them from letting their technical standards slip or from presenting misleading technical information. Misleading information would be recognized and stated by the competing groups.

### Table 4. (Continued)

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<th>Role: City of Sandville</th>
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<td><strong>General Attitude:</strong> The Army is bailing out on your community, which has supported the Army for a long time. You feel that as part of the trade-off for losing a major local employer, the city deserves to annex the part of the base nearest you. You want most of the cleanup effort to focus on that part of the site. You want the Army to do a lot of cleanup work, but you don't want the agencies to see the site as dirty. You are willing to compromise, as long as the general intent of the cleanup meets your objectives.</td>
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<td><strong>Hot Buttons:</strong> Clean water on the your side of the base. The landfill has already contaminated some of your drinking wells from the deep aquifer, and you want to make sure they treat water. You have a great fear that the Army will carry out some minimal program, and then leave you holding the bag.</td>
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<td><strong>Agenda items you want to see approved:</strong></td>
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<tr>
<td>1. You think that additional plume-definition wells are necessary on the north side of the site</td>
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<tr>
<td>2. You think the landfill should be dug up and moved, or at least capped to reduce contact</td>
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<td>3. Long-term commitment to ground-water cleanup is very important</td>
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<td>4. Although the contaminant levels are low in soil, soil is not completely clean, and there are pinpoint contaminant sources which pose danger. Something must be done to address these.</td>
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<th>Role: State Water Board</th>
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<td><strong>General Attitude:</strong> EPA has grabbed too much control of what happens on this site. You are the main regulating agency for the state, and your requirements are generally more stringent than EPA's, so you feel you should set the pace and the tone for the meeting. EPA and the Army have developed a written agreement, but you sense a danger that the state's interests may not be well represented by this agreement. The investigation has been fairly thorough, and only a little remaining investigation needs to be done.</td>
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<td><strong>Hot Buttons:</strong> Landfill closure is critical. This landfill is unlined and unpermitted, which are requirements for all other landfills in the state. Even though risk calculations and chemical concentrations may be low, it makes good sense to cap the landfill. In fact, the parties involved should recognize that you could push them to dig up the material and line the landfill also, so you are compromising for them by only expecting a landfill cap.</td>
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<tr>
<td><strong>Agenda items you want to see approved:</strong></td>
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<tr>
<td>1. You think that a few additional wells are necessary to define the plume</td>
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<tr>
<td>2. You think the landfill should be capped</td>
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<tr>
<td>3. Ground water cleanup should proceed until some reasonable level of low concentrations is reached</td>
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<td>4. You would like the cleanup plan to address site uses during the time of cleanup (how do we protect people from exposure before cleanup is done?)</td>
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E. Professionalism

1) Exercise 8: After a few weeks of group design, short answer discussion, writing, and other “active” learning, the students will view a lecture as something fresh and different. Based on the assumption that specific “war stories” will convey a concept more memorably than generalized statements, the author uses a published list of “professional practice rules” as a springboard to give examples from his experience. Table 5 includes examples of some of the “professional practice rules” and the nature of the comments to each. The novelty of this exercise wears off quickly, so one lecture period is probably sufficient. To keep the lecture moving, most rules should warrant less than one minute of comment, with a similar length of time available for questions.

2) Exercise 9: As a summary of all the exercises dealing with ethical issues, students are asked to individually reflect on the ethical themes which they consider to be the most important. Exercise 9 outlines an individual writing assignment to guide these reflections. The format of a “corporate policy statement” forces them to express the “spirit” of the ethical themes rather than just the “letter.” The text of the exercise is:

“Write a one-page corporate policy statement on engineering ethics. Assume that this statement will be distributed company-wide, it will govern everyone’s ethical decisions, and it may someday be used in a court-of-law to defend your company’s practices.”

IV. Feedback and Evaluation

While it is difficult to quantify the effectiveness of the broad-ranging and subjective topics covered by these exercises, the initial indications from the students are that they were effective and fresh ways to study a difficult topic. For example, students were asked to evaluate each of the activities in the design class. On a four-point scale, the average evaluation for the ethics exercises was 3.3, as summarized in table 6. For comparison, the technical exercises completed in class received an average evaluation of 3.0, and the three design projects received an average evaluation of 3.2. Ratings for ethics exercises were statistically different from the technical exercises at the 5% significance level, but were not statistically different from the projects even at the 10% level. On the whole, students valued not only the material but also the various learning styles used for the exercises. Based on the evaluations in table 6, the students most appreciated the group discussion and some of the group writing, were slightly less enthusiastic about role playing, and least appreciated the individual writing and lecture approach. In addition, exercises done early in the semester (Exercises 1, 2, and 3) were rated higher than exercises done later in the semester (Exercises 7 and 8).

Written feedback was not extensive, although comments were solicited by the author. The following comments are those which were applicable to the ethics exercises:

<table>
<thead>
<tr>
<th>Example Rules</th>
<th>Instructor’s Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The majority of your reputation from your first employment engagement will be decided on the basis of your first two weeks’ performance.</td>
<td>This rule heightens the importance of reputation in the workplace, especially as it relates to work assignments and job security.</td>
</tr>
<tr>
<td>2. Never badmouth your employer; if such is warranted, it is time to move on.</td>
<td>Discussion of this rule focuses on a professional’s attitude and the importance of attitude on performance.</td>
</tr>
<tr>
<td>3. Most employers deserve at least two years to demonstrate their worth as a good professional “home” for you; to change employment more frequently is often regarded as an indication of instability on your part.</td>
<td>Students may not recognize the need for a “settling in” time.</td>
</tr>
<tr>
<td>4. In the long run, professional registration is worth a bit more than a master of science degree, but you will eventually need both in order to play hardball in the profession.</td>
<td>While this rule may not hold true for other engineering disciplines, it serves as a springboard for discussion of the merits of both professional registration and continuing education.</td>
</tr>
<tr>
<td>5. You must build a clientele within your own organization; have people clamoring for your services.</td>
<td>Young professionals should recognize that their “clients” are the people they work with every day, who either desire to give them more work or do not trust their judgment and professional abilities.</td>
</tr>
<tr>
<td>6. Learn to provide clients with excellent service, and of better quality and delivery time than anyone else. They will learn to pay you a fair fee for this, and to call on you first.</td>
<td>Successful young professionals are those who learn early on to “take care” of their clients. This sense of ownership should not be possessive, but it should be protective.</td>
</tr>
<tr>
<td>7. Manage your relations with others so that the amount of “freight” that they have to pay in dealing with you is less than 50-percent of the total effort. Wise folks keep their freight bills at less than those with whom they associate.</td>
<td>This rule diplomatically presents a way to rise above the “who owes whom” tally in the workplace.</td>
</tr>
<tr>
<td>8. You should occasionally be entitled to at least ten minutes of free telephone consultation from your old professors (20 minutes if you have been following the above rule assiduously).</td>
<td>Without violating rule 7, maintaining a network of technical advisors is the key to the trait of resourcefulness.</td>
</tr>
</tbody>
</table>

Table 5. Selected professional practice rules (Exercise 8).
I loved the format of the course and feel that I have learned more in this class than in any of my other classes…

This class really makes you think…

Excellent

Give more thorough descriptions for role playing so as to avoid differing interpretations…

It would be helpful if you could give your opinion on things like ethics and professional goals…

Public meeting needs more focus and control…

Public meeting was an excellent exercise and I learned a lot…

All excellent

Prepared for real world experience…

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Average Student Evaluation*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethics Problems - Billing (Table 1)</td>
<td>3.4</td>
</tr>
<tr>
<td>Ethics Problems - Bad news (Table 2)</td>
<td>3.5</td>
</tr>
<tr>
<td>Ethics Problems – Written Opinions (Table 3)</td>
<td>3.4</td>
</tr>
<tr>
<td>Ethics Problems – Misinterpretation (Table 4)</td>
<td>2.7***</td>
</tr>
<tr>
<td>Relating to Your Employer – Time Off (Table 5)</td>
<td>3.3</td>
</tr>
<tr>
<td>Relating to Your Employer – Desirable Traits (Table 6)</td>
<td>3.2</td>
</tr>
<tr>
<td>Public Meeting (Table 7)</td>
<td>3.2</td>
</tr>
<tr>
<td>Sixty-Seven Professional Practice Rules (Table 8)</td>
<td>3.1</td>
</tr>
<tr>
<td>Ethics Policy Statement (Table 9)</td>
<td>2.7**</td>
</tr>
</tbody>
</table>

All Ethics Exercises | 3.3

All Technical Exercises (for comparison) | 3.0

All Projects (for comparison) | 3.2

* Evaluation scores are averaged for a study period of three years (three classes with 19 respondents in each). N = 57 unless otherwise indicated. Scoring system was as follows:

4 = Excellent, activity was very effective at improving your skills
3 = Good, activity was effective at improving your skills
2 = Average, activity was OK, but should be improved
1 = Below average, activity was only marginally worthwhile
0 = Poor, throw it out

** N = 38 (exercise dropped due to poor feedback from evaluation)

*** N = 19 (exercise dropped due to poor feedback from evaluation)

Table 6. Student evaluations of ethics exercises.

V. ADDITIONAL METHODS FOR TEACHING ETHICS

As an additional method for teaching ethics, I have also used a game called “The Ethics Challenge” created and distributed free of charge by Lockheed Martin (310 N. Westlake Blvd., Ste. 200, Westlake Village, CA 91362). The game uses Dilbert characters and humor to help students wrestle with various ethical dilemmas. Discipline-specific ethics cases are also available on various Internet sites and in some professional technical magazines (I have noted several in recent issues of the AEG News, published by the Association of Engineering Geologists).

Case histories may also be converted to ethics and advocacy exercises by using role playing, or if time is available, by creating a mock trial, complete with professional experts, attorneys, judge, and jury. Two excellent sources of civil, environmental, and geological case studies that may readily be used for role playing exercises are books by Anderson and Trigg, and Shuirman and Slosson.

VI. CONCLUSIONS

The time requirements for the ethics exercises described above was six lecture periods, one homework assignment, and one laboratory period for the public meeting. For this small commitment, students were exposed to a broad range of ethical and behavioral issues, using a variety of learning methods. They participated with moderate to high enthusiasm, depending on the particular exercise. Based on the evaluations, they seemed to agree that the exercises were an effective way to teach a very subjective topic.

I recommend that each teacher modify the exercises to reflect one’s own experience, and to reflect the anticipated ethical issues for the specific engineering discipline of the course.

REFERENCES