AC 2009-1565: TWO WAYS OF USING CASE STUDIES TO TEACH ETHICS

John Brocato, Mississippi State University

John Brocato serves as Coordinator and Instructor in the Shackouls Technical Communication Program in the James Worth Bagley College of Engineering at Mississippi State University. He designed and helps teach GE 3513 Technical Writing and works closely with engineering departments on enhancing the technical communication content in their curricula. He holds bachelor’s and master’s degrees in English from MSU and previously taught in the English Department there. He is a member of ASEE and serves as its Campus Representative for MSU.
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Introduction

Professional ethics, like many other areas of academic study, is best taught through synthesis and application. Exposing students to the importance of ethics via, for example, a lecture on the NSPE Code of Ethics or a reading assignment on plagiarism may accomplish something on its own, but such relatively low-stakes activities do little to put students in the position of contemplating and then making ethics-related decisions – they do little, in other words, to bring the subject to life for students.

One simple way to engage students more fully in the experience of professional ethics is the use of case studies. The usefulness of case studies in engineering curricula has been documented in research literature for nearly 20 years. Although case studies can take various forms, the cases discussed here serve as writing prompts in a technical communication program for engineering students. Whether in a required communication course for undergraduates or in a writing workshop for graduate students, these cases vicariously immerse students in the details of a particular scenario that, in the end, requires some sort of ethical decision-making, sometimes involving literal life-or-death judgments and often requiring written documentation of said decisions.

Described in this paper, then, are two case studies that allow students to navigate the professional ethics of authentic engineering situations. The first case study, “The Pendergrass Circuits E-mail,” is a one-page story that literally puts students into the narrative as a character, requiring them to read, analyze, discuss, and reflect on the story’s details before deciding what sorts of actions and written documentation are necessary. The second case study involves close analysis of the space shuttle Challenger disaster, in particular the written and oral communication that took place prior to the disaster itself. As this paper shows, using case studies as described here can provide students with valuable exposure to the types of decisions they might have to make in their professional careers while also providing engineering programs with a sound method for assessing their performance relative to ABET Program Outcomes (f) (professional ethical responsibility) and (g) (effective communication).

Case Study 1: The Pendergrass E-mail Exercise

The beauty of using narrative case studies in educational settings is their finiteness: they create scenarios with a relatively closed set of details wherein students can analyze a realistic professional situation as a way of preparing for similar situations in their upcoming careers. Below we discuss one such case study that has proven especially useful.

The “Pendergrass Circuits E-mail” exercise (hereafter simply called Pendergrass) provides a short-story-like narrative that puts students directly into the scenario described in the case itself (first line: “You are an engineer at Pendergrass Circuits, Inc….”). Pendergrass was created specifically for this course, though the story structure is borrowed and modified from an older case study originally created and used by Dr. Dan Embree in a technical writing course formerly offered by the Department of English at Mississippi State University. Pendergrass actually began...
as a more prescriptive assignment, explicitly telling students what type of document to write, what some of the major document contents should be, and to whom the document should be sent. Over time, we chose to make the requirements more open-ended and require that students decide for themselves how to handle the situation. Figure 1 below shows the full Pendergrass content with a paragraph of student instructions at the end.

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**Pendergrass Circuits E-mail**

You are an engineer at Pendergrass Circuits Inc., a small electronics company in Random Lake, Wisconsin. One Wednesday evening at 8:33, while checking your company e-mail account from home, you receive an e-mail message from your fellow engineer Bart Sellers. The message reads as follows:

We’ve got a problem. I missed my connecting flight. I’m stuck here in the Bowie, Nebraska airport. I’m sending you this on the company laptop. Koenig is going to fire me when he finds out, but it really wasn’t my fault. I got a taxi and was on my way to the airport to catch my flight to Sallisaw, Oklahoma to install replacement chips on some recalled PGS-480 boards when the taxi driver gets a message on his radio that his wife’s just gone into labor – so he floors it for the hospital. I started asking him what he was going to do about me, but all he kept saying was “I’m having a baby!” He disappeared inside when we got to the hospital. I went and looked for him but I couldn’t find him. So I went back out to the taxi and tried to radio the dispatcher for help, but I couldn’t figure out how to make it work. It was 5:58. My plane was leaving at 6:35. Then I saw the keys in the ignition. I didn’t know what else to do, so I got in and tried to drive to the airport, but I got lost because I don’t know Bowie too well and I still couldn’t figure out how to work the radio. A rancher near the South Dakota border finally told me how to get to the airport, but I didn’t get parked and into the terminal until 8:07, and the next flight to Sallisaw on any airline doesn’t leave until 7:55 tomorrow morning. Which will put me into Sallisaw at 11:05, but I’m supposed to be at the customer’s office at 9 AM. I tried calling them but there was no answer and no voice mail and I don’t have an e-mail address for them. Can you call them and reschedule the installation? The customer is Darwin Aero Works in Sallisaw, Oklahoma. The address should be in the Darwin file. Tell Koenig that I’ll take responsibility for the taxi thing if there’s trouble. Reply as soon as possible and let me know you got this. Later.

After replying to Bart’s e-mail, you find that there is indeed no answer at Darwin Aero Works, and you know from experience that Darwin rarely answers e-mail. Rex Koenig, your boss, is two hours away at an IEEE dinner, and your calls to his cell phone have gone unanswered; he apparently cannot be reached until he gets to work at 8 AM tomorrow. Furthermore, you are leaving tomorrow at 5:30 AM on a six-hour flight to Nova Scotia to assist a new customer with an installation.

**ASSIGNMENT:** Decide as a team how you should handle this situation. Write any documents that are part of your solution, and be prepared to explain your reasoning to the rest of the class, including any assumptions you make about incomplete story details (these assumptions should obviously be exceedingly logical). Consider well which details are essential and which ones are not. Think carefully about what your responsibilities are in this situation as well as to whom you are responsible. Do not waste time worrying about anything “farfetched” – handle the problem as it lies.

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Figure 1. Content for the Pendergrass Circuits E-mail Exercise

As Figure 1’s “ASSIGNMENT” paragraph shows, we typically use Pendergrass as a collaborative in-class exercise, where students work in instructor-created teams deciding how to handle the situation, writing the documents they deem necessary, making (hopefully) logical assumptions about incomplete details, and preparing to explain their decisions to the rest of the class. Although we originally intended for this assignment to focus on writing correspondence and responding to different readers, student responses immediately tended toward the ethical dilemmas in the scenario, the major examples of which are listed below (actual student quotes):
• “We just need to let Darwin know that Bart won’t be there for the scheduled installation. That’s the highest priority. The rest will work itself out.”
• “I’d mark the e-mail ‘unread’ and pretend I never saw it. It’s Bart’s problem, not mine.”
• “E-mail Bart and tell him that he needs to handle this. It’s not our problem.”
• “What if Bart gets arrested for grand theft auto?”
• “We don’t want Koenig [the boss] to be blindsided by Bart’s taxi problems.”
• “Wasn’t Bart basically kidnapped, though? I mean, before he took the taxi, he tried to get the driver to stop, but he wouldn’t listen. He was wronged too.”
• “How will the cab company ever know who took the taxi? Unless the driver had a camera in the car or got credit card information from Bart, how would they ever track him down? Wouldn’t they be happy just to get their cab back?”
• “Won’t it look unprofessional if we contact Darwin and then Koenig contacts Darwin with different information? Shouldn’t they hear it from one person?”

Hence, in addition to facilitating discussion of more basic communication-related issues – what details to include, how to structure the written communication, whether to leave voicemails – Pendergrass also prompts students to examine the choices they might have in a situation like this. Our goal in using this assignment is not to tell students the way such a situation should be handled but to get them to consider as many factors as possible en route to taking a professionally responsible course of action. The basic steps we use when using Pendergrass as an in-class exercise are as follows:

1. Students read the distributed case study and then discuss the scenario in their teams (these teams have been assembled in a previous meeting).
2. Teams collaborate to write any documents they deem necessary as part of the solution to the case as well as any assumptions they made along the way (mainly to account for incomplete story details). Typical documents include e-mails to all involved parties along with transcripts of text messages and voicemails, depending on what assumptions students have made about these media. Teams may write by hand or type if a team member has a laptop.
3. Teams turn in one copy of their documentation per team (see Figure 2 below for an example). We then use a document camera to show each team’s documentation on the screen; teams explain and justify their choices, and the class critiques both their choices and their writing.
4. The instructor marks each team’s documentation to provide guidance and to capture what was said verbally during class. Since our in-class projects typically count as daily/participation grades, and since such projects are executed quickly and with little preparation time, we do not grade these documents as strictly as we do larger, out-of-class assignments. The point of in-class work like this should be the process of analyzing ethics and communication.

Plan of Action:
1) Contact Bart Sellers via email informing him of all aspects of the steps we suggest to solve this dilemma and ensure I am the only one he informs of his troubles until he can handle them in person.
2) Contact Rex Koenig via email informing him that Bart will be arriving to Sallisaw late and request that he contact Darwin Aero Works before the scheduled Nine O’Clock interview.

Letter to Bart:
Bart,

Sorry about your luck. As you may know, Rex Koenig will be unreachable until 8 AM. I understand your flight leaves at 7:55 AM. I suggest you email Darwin Aero Works (DAW) to inform them you will be late. I am unable to contact DAW, and I have a 5:30 AM departure for a six-hour flight. I will email Rex to let him know you missed your flight and won’t be in Sallisaw until 11:05 AM. Hopefully Rex can iron out the details with DAW by the time you land. Don’t worry about giving all the excuses to DAW or Rex; just let them know there was trouble with your flight at the airport and you’ll be a few hours late in the morning. Call Rex as soon as you land to confirm your appointment time if he’s rescheduled one.

[writer]
Retail and Installation Representative
Pendergrass Circuits, Inc.
Random Lake, WI

Letter to Rex:
Rex,

Bart missed his connecting flight and will not be able to meet his Nine O’Clock appointment. Neither Bart nor I were able to contact Darwin Aero Works (DAW) and notify them of Bart’s tardiness. Bart’s flight will be in flight from 7:55 to 11:05 and will not be able to contact DAW until he lands. DAW is not known to check their email regularly, and the only person who can contact via telephone is you because I will also be in flight in the morning. If you could call DAW and reschedule Bart’s appointment for later that day or any other solution you can reach with them. I have requested Bart to call you upon landing and you update him fully on his new agenda. I believe this should preserve our professional relationship with DAW and avoid any negative outcome.

[writer]
Retail and Installation Representative
Pendergrass Circuits, Inc.
Random Lake, WI

Figure 2. Sample Student Documentation for Pendergrass

Despite our open-ended approach to solving Pendergrass, we do ultimately try to steer students toward courses of action that consider such tenets of classical ethics as utility and care. With Pendergrass, taking care of Darwin is indeed the highest priority; whatever steps students decide to take, one of them should definitely be to ensure their client knows that Bart will not be there for the scheduled appointment and that Pendergrass as a company is working to reschedule the appointment with as little inconvenience to Darwin as possible. As demonstrated in Figure 2, emailing Rex Koenig with sufficient information to reschedule the appointment (hopefully well before 9:00am) is probably the most reliable solution since the scenario dictates that neither Bart nor the writer will be available to do this in time during business hours the next day.

Case Study 2: Challenger Documentation

Using case studies based on historical events has a distinct disadvantage compared with second-person narrative cases: historical events leave no reasonable room for writers to insert
themselves into the situation (writers could do this, of course, but the process would likely be even more artificial than a semi-fictional case study). This lack of insertion can mean that students fail to find the historical case study compelling or engaging, perhaps eventually resulting in an ineffective educational experience.

This disadvantage, however, can be outweighed by certain elements of the most useful historical case studies. The space shuttle Challenger disaster, for example, is remarkably useful for several reasons:

- **Extensive documentation** – Memos, reports, and briefing charts relevant to the shuttle’s faulty o-ring design date from as far back as October 1977, 3 ½ years before the very first shuttle flight and nearly 9 years before Challenger’s ill-fated launch. For studying ethics as a part of writing courses, these documents are invaluable.

- **Inherent safety factor** – At their most basic, space shuttle flights involve attaching seven people to a craft that utilizes millions of pounds of incredibly combustible material as a way to break free of gravity and eventually attain ascent speeds of one-half mile per second\(^{10}\). The engineering required to complete these tasks successfully therefore carries safety considerations of the highest order.

- **Highly complex system** – Many consider the space shuttle to be the most complex system ever designed; thus, the writing relevant to this system is a true form of “technical” writing.

- **High-profile scenario** – One of the most critical considerations about Challenger documentation is that its eventual audience was not limited to rocket scientists. The high-profile nature of the shuttle program in the 1980s meant that the general public was paying close attention, which also resulted in the public-relations nightmares NASA faced once the launch delays began\(^{11}\). After the disaster, though, technical documents explicitly discussing the flawed o-ring design and the likely outcome of ignoring the problem became available to anyone wishing to read them, from non-technical members of the Rogers Commission to newspaper readers around the country. This level of attention means that Challenger documentation is often held to uncompromising standards, and even if such hindsight is unfair, the phenomenon itself is a crucial lesson for students to learn.

- **Multidisciplinary work** – In classes with six to eight engineering majors represented, some students gripe about studying Challenger because “it’s for aerospace majors.” In truth, the space shuttle system is as interdisciplinary as it is complex, though the nontechnical issues we discuss – effective communication, ethical codes, individual versus corporate responsibility – are probably more important than application to any specific discipline; and these nontechnical issues, of course, can be applied to any working professional.

Our approach to using Challenger is far more formal and lengthy than our approach to using cases like Pendergrass, often spanning the entire latter half of a semester. The following list provides an example of one typical incorporation of Challenger in a given semester.
Context: We discuss the concept of professional ethics itself and its inherence to communicative acts, followed by a preemptive “defense” of using Challenger that is based on the bulleted list shown just above.

Document analysis: We assign one Challenger-related document to each student team, tasking them with leading an in-class discussion on their document that examines audience, context, ethical soundness, and grammar/style. (For this purpose, we maintain an online list of major Challenger documents at [http://sites.google.com/site/ge3513/majorchallengerdocuments](http://sites.google.com/site/ge3513/majorchallengerdocuments).) Figure 3 below shows the information page we provide to students so they can prepare for their document analysis.

The Challenger Memos

As assigned to your teams below, read and discuss the Ray 10/21/77 chart, the Ray/Miller 1/19/79 memo, the Boisjoly 7/31/85 memo, the Russell 8/9/85 memo, the Ebeling 10/1/85 memo, and the Kilminster 1/27/86 fax, all pre-Challenger disaster documentation. Be prepared to analyze and discuss your assigned memo for the rest of the class, ultimately telling us whether you think the memo is an example of effective technical communication. In arriving at this conclusion, take the following ideas into account:

1. **Readers**: who were the short- and long-term readers?
2. **Context**: in what sort of political/social/cultural/professional environment were these memos written?
3. **Chains of command**: what were the writers’ limitations on both recommending actions to others AND taking actions themselves?
4. **TC basics**: how sound are the memos’ diction, sentence & paragraph structure, overall document design, grammar, clarity, etc.?

Use textbook sections 13.2 through 13.4 for help if necessary.

NOTE: This in-class project is based solely on group discussion and participation – nothing written need be turned in to me.

Document Assignments

Team 1: the Ray 10/21/77 chart – [http://history.nasa.gov/rogersrep/v1p233.htm](http://history.nasa.gov/rogersrep/v1p233.htm)

Team 2: the Ray/Miller 1/19/79 memo – [http://history.nasa.gov/rogersrep/v1p236.htm](http://history.nasa.gov/rogersrep/v1p236.htm)

Team 3: the Boisjoly 7/31/85 memo – [http://history.nasa.gov/rogersrep/v1p249.htm](http://history.nasa.gov/rogersrep/v1p249.htm)


Team 5: the Ebeling 10/1/85 memo – [http://history.nasa.gov/rogersrep/v1p252.htm](http://history.nasa.gov/rogersrep/v1p252.htm)

Team 6: the Kilminster 1/27/86 fax – [http://history.nasa.gov/rogersrep/v1p97.htm](http://history.nasa.gov/rogersrep/v1p97.htm)

Figure 3. Information Page for Challenger Document Analysis

DVDs: We typically watch portions of two Challenger DVDs to help provide background information. Mark Maier’s “A Major Malfuction…”: The Story Behind the Space Shuttle Challenger Disaster is a comprehensive look at the disaster from 1960s space missions through the development of the Space Transportation System (STS) to the commission hearings that followed the failed launch. The documentary examines several documents discussed in class and features interviews with some of the writers. Roger Boisjoly’s An Ethics Case Study – The Chronological Presentation of the Space Shuttle Challenger Disaster, on the other hand, is a
video of a presentation Boisjoly gave in 2005 covering his experiences at Morton Thiokol, Inc. (MTI – the company responsible for the shuttle’s solid rocket boosters) and the criticality of maintaining sound ethics in the professional world. Boisjoly – an engineer turned whistleblower at MTI during Challenger, described during 1986 commission hearings as “the top engineer” on the rocket joints\(^1\) – describes the technical design of the solid rockets at an easily comprehensible level and analyzes several documents (including some he wrote), providing insights into both engineering and the writing process along with a glimpse of the politics involved in being blunt about poor engineering work. We interweave the students’ document analysis with these DVDs, showing relevant parts of the DVDs during their analyses, stopping the DVDs at various points to highlight significant document passages, and so on.

**Research paper and presentation:** In their teams, students research and write a report on one of several topics related to Challenger and ethics. The topics themselves (which, in fact, do not always involve Challenger) vary from an in-depth analysis of several documents to a comparison of Challenger with another engineering disaster to a discussion of risk assessment during Challenger as evidenced by the written record. This research paper is typically done in two installments, one for the **Abstract** and **Introduction** sections and another for the completed paper, which incorporates the revised first two sections. Both installments are subject to two drafts, the first of which is peer-reviewed in class. Students also deliver an oral presentation at the end of the semester covering their research-paper topic.

**Assessment and Usefulness for ABET**

Because our program serves our entire college of engineering, the departments in the college use student data from our course to edify their ABET outcomes. The information we provide includes student grades on major assignments and detailed descriptions of those assignments. While in-class work like Pendergrass does not usually appear in the ABET data, units like the one on Challenger form an important part of the information we provide. In particular, the Challenger assignment and related work can help fulfill four of ABET’s program outcomes a-k (the details below appear in modified form in an earlier paper\(^9,12\)):

“(d) an ability to function on multidisciplinary teams” – Although we allow some compromise regarding the makeup of student teams, our default arrangement is to make the teams as multidisciplinary as possible mainly to remove students from their comfort zones and hopefully thereby challenge them more as they write and speak collaboratively. In semesters where we also allow teams to choose a topic based on research in which they themselves have participated, we still try to maintain teams of different majors so that students still get the experience.

“(f) an understanding of professional and ethical responsibility” – Challenger is unquestionably one of the most commonly cited examples of lapsed professional ethics in modern history, and our use of it as a case study requires extensive examination of numerous ethical issues from numerous perspectives: the responsibility of engineers at NASA and MTI to communicate thorough, accurate information about o-ring design flaws in an urgent manner to appropriate supervisors; the responsibility of NASA and MTI management to process the engineers’ information without allowing that information to be unduly tainted by economic or scheduling pressures; the responsibility of MTI to withdraw a design they eventually knew to be faulty
regardless of financial loss; the responsibility (if any) of those most fervently against the launch to work outside the official chain of command to stop the launch if necessary; and so on.

“(g) an ability to communicate effectively” – By the time students complete the work in question, they have written an in-depth paper that argues a specific thesis and supports it with relevant research, and they have delivered a formal presentation on the same topic. The paper is revised through two iterations with two drafts per iteration, one of which is peer reviewed. Their audience is one of the most important they will encounter in their professional careers: an educated lay audience, intelligent readers who may not necessarily possess specialized knowledge of the topic at hand. As such, we grade students’ Challenger deliverables rigorously, and we use the resulting grades as a barometer not only of how well students communicate (g) but also how well they function on multidisciplinary teams (d) and how well they have begun to understand the ramifications of professional and ethical responsibility (f). Our grading process is described in detail in an earlier paper. Figure 4 shows the metric our departments use to gauge student outcomes in these areas (data relevant to this paper is highlighted in yellow):

<table>
<thead>
<tr>
<th>METRIC</th>
<th>80% of students will earn a grade of 80 (B) or higher on GE 3513 presentations and writing assignments.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• 52 out of 54 students (96%) earned an 80 or above on all presentations.</td>
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<tr>
<td></td>
<td>• 47 out of 54 students (87%) earned an 80 or above average on the major writing assignments.</td>
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<tr>
<td></td>
<td>• 49 out of 54 students (91%) earned an 80 or above on the collaborative/multidisciplinary research/professional ethics assignment.</td>
</tr>
<tr>
<td></td>
<td>• 44 out of 54 students (81%) earned an 80 or above on the final-exam document.</td>
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</table>

Detailed information on all assignments is available online at [http://sites.google.com/site/ge3513/](http://sites.google.com/site/ge3513/).

Figure 4. Mechanical Engineering Student Data for Fall 2008

“(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context” – One of the most enlightening aspects of in-class shuttle discussions involves the impact the space shuttle “industry” can have on entire communities and economies – how, for example, MTI’s securing of the solid rocket booster contract in 1973 affected the state of Utah but also how this situation ultimately affected Challenger’s fate by requiring initially unassembled (and therefore more risk-susceptible) rockets, since assembled rockets were supposedly too heavy to transport via rail from Utah to Florida. Concerns like these help prevent students from seeing the complex Challenger scenario (and others like it) in simplified, pure right-and-wrong terms.

Conclusions and Future Work

Case studies like the ones described here are a highly effective way to engage students in substantive work on professional ethics and measure ABET program outcomes. Unfortunately, the university course evaluations we use do not provide enough specific feedback on student perceptions of case studies to be useful in this setting, although our earlier paper contains assorted verbal and written comments from students regarding shuttle case studies. Thus far, we have not created a survey to gauge student perceptions, so creating such a survey is definitely the next step. Future work also includes the ongoing process of incorporating more and different
case studies in this process, since reusing the same cases over and over is good neither for student-teacher boredom nor for academic integrity.

**References**


