Systematic Approach to Ethical Decision Making Using Matrices

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Abstract - With origins in the decision matrices used to choose between competing alternative designs, the Ethical Decision Matrix is a practical way to ensure that a student will use a systematic approach in engineering ethical situations and at least reflect on a broad range of considerations. Alternative ethical solutions are evaluated using a subset of the professional canon of ethics from the National Society of Professional Engineers. The columns of the decision matrix correspond to the alternative ethical solutions; the rows correspond to the canons. The students fill in the matrix blanks with a “yes”, “no” or “maybe” (with perhaps a few words of explanation) to indicate if the solution is consistent with a particular canon. A process for introducing this method to students is described and illustrated for the case of an engineer who feels design changes may have compromised the safety of a bridge.

Index Terms – decision matrix, ethics, freshman course

INTRODUCTION

The importance of ethics in the engineering curriculum has been emphasized in ABET 2000 Criterion 3, and addressed in previous publications ([1]-[4]). Those publications have led to a consensus that the best way to address engineering ethics in the classroom is the case study approach. We propose a tool for using the case study approach in one particular type of classroom: the introductory course for first-year students. That tool is called the Ethical Decision Matrix.

Development of that tool arose from the need to address the particular problems posed by the introductory course. The case study approach indeed achieves one key goal: It gets the students actively involved. However, problems remain.

• Limited class time is available. At most, one or two class periods can have ethics as their main topics.
• The case study approach tends to lose focus. Students may enjoy the open discussion. But they may also leave class feeling that they have not learned anything. As Brannigan notes, they may walk away believing that engineering ethics imposes no greater requirements than being personally honest and applying general concepts of integrity [1].
• A general case study discussion may conflict with the rest of the introductory engineering course. In other engineering areas, the student is enabled, by means of specific tools, to acquire important skills. Unfocused discussion of ethical issues, by contrast, may suggest that mere verbal fluency is more important than either tools or skills.
• The general unfocused discussion of cases is difficult to apply to weekly homework problems. So, unlike the tools learned in other classes, ethics becomes a one-shot affair.
• A general case study discussion is not testable. The resulting absence of an ethics question on the final exam carries a strong, if unintended, message to the student. Contrary to what the professor may have said in class, ethics isn’t really important.
• Unfocused case study discussion may not provide opportunities for students to make discoveries.

PROPOSED APPROACH

We began by addressing the issue of limited time. How might a single class period be dedicated to the topic of ethics?

One aspect of ethics limited enough to be dealt with in a single class is the role of a professional canon of ethics in ethical analysis. Addressing this issue does not imply that the professional canon is the only important consideration of engineering ethics. But it is a consideration that an engineer must not ignore. By seeking a career in engineering, an individual is agreeing to abide by the ethical canons that the engineering profession has adopted. While there are differences among versions of these canons, the following version, abstracted from the National Society of Professional Engineers, is representative and useful for teaching purposes.

Engineers will:
• Hold paramount the safety, health and welfare of the public
• Perform services only in the area of their competence
• Issue public statements only in an objective and truthful manner
• Act for each employer or client as faithful agents or trustees
• Avoid deceptive acts
• Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation and usefulness of the profession.

These canons are on the whole accessible to most students, many of whom have already encountered the concept of professional ethics in the form of the Hippocratic Oath.
Oath of the physician. However, at least three points are less accessible to the first year student, and must be made explicit. First, the word “paramount” means “superior to all others”. Second, a “faithful agent or trustee” is a person who foregoes personal interests in order to act in the primary interest of an employer or client. Third, the final canon is a sort of “spirit-of-the-rules-rule” that the student might have encountered in the form of unsportsmanlike conduct penalties in athletics. That is, the final canon, like a penalty for unsportsmanlike conduct, marks as unethical certain activities, that, while not literal violations of any one particular rule, are clearly counter to the spirit of the rules taken as a whole.

Having discussed the concept of a canon, the next step is to consider cases that illustrate application of the canons. Here one must choose between presenting detailed and highly realistic cases, or simplified and schematic cases. There are good arguments to be made for each of these options. But we have opted for simplified and schematic cases, mainly on the grounds of time limitation. An example of such a schematic and simplified case is now presented.

You are a civil engineer on a team designing a bridge for a state government. Your team submits what you believe to be the best design by all criteria, at a cost that is within the limits originally set. However, some months later the state undergoes a budget crisis. Your supervisor, also a qualified civil engineer, makes design changes to achieve cost reduction that he believes will not compromise the safety of the bridge. You are not so sure, though you cannot conclusively demonstrate a safety hazard. You request that a new safety analysis be done. Your supervisor denies your request on the grounds of time and limited budget. What do you do?

The next issue is what to do with the case. It is tempting to open the class to general discussion. This provides an enjoyable class session to the students. However, it is likely to be perceived as a mere vacation from engineering, not a contribution to engineering education. The rest of engineering seeks to provide criteria for distinguishing better from worse solutions to a problem. An open-ended inconclusive case discussion, by contrast, delivers the message all solutions are equally good (or bad).

### TABLE I

<table>
<thead>
<tr>
<th>CANON</th>
<th>Go along with the decision</th>
<th>Appeal to higher management</th>
<th>Quit your job</th>
<th>Write your state representative</th>
<th>Call a newspaper reporter</th>
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</thead>
<tbody>
<tr>
<td>Hold paramount the safety, health and welfare of the public.</td>
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<tr>
<td>Perform services only in the area of your competence</td>
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</tr>
<tr>
<td>Issue public statements only in an objective and truthful manner</td>
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<tr>
<td>Act for each employer or client as faithful agents or trustees</td>
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<tr>
<td>Avoid deceptive acts</td>
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<td></td>
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<tr>
<td>Conduct themselves honorably …</td>
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</table>
In order to avoid creating this unintentional contrast between ethics and engineering, we focus on a particular tool: the **engineering decision matrix**. That tool presents a way of applying the canons of engineering ethics. Conceptually, the ethical decision matrix is simple. The rows of the matrix are the canons of engineering ethics. The columns are possible ways to resolve the problem. Each box of the matrix must be filled with a very brief answer to the question: “does this one particular solution meet this one particular canon?” Like other engineering tools, the ethical decision matrix is a way to divide-and-conquer a problem, rather than trying to address all its dimensions simultaneously.

### Table II: Ethical Decision Matrix with Responses

<table>
<thead>
<tr>
<th>OPTION CANON</th>
<th>Go along with the decision</th>
<th>Appeal to higher management</th>
<th>Quit your job</th>
<th>Write your state representative</th>
<th>Call a newspaper reporter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hold paramount the safety, health and welfare of the public.</td>
<td>No Total assent may put public at risk</td>
<td>May</td>
<td>No If you just quit, risks less likely to be addressed</td>
<td>Yes Potential risk will be put before public</td>
<td>Yes Potential risk will be put before public</td>
</tr>
<tr>
<td>Perform services only in the area of your competence</td>
<td>Yes You are not a safety expert</td>
<td>Yes Though not a safety expert, you are competent to surface an issue</td>
<td>Maybe</td>
<td>No You are not an expert in government relations</td>
<td>No You are not an expert in press relations</td>
</tr>
<tr>
<td>Issue public statements only in an objective and truthful manner</td>
<td>No Silence may seem untruthful assent</td>
<td>Maybe You are publicly silent, but have registered dissent</td>
<td>No Quitting in order to avoid the issue is being untruthful</td>
<td>Maybe Your personal involvement may hurt your objectivity</td>
<td>No The press is likely to sensationalize what is as yet only a potential issue</td>
</tr>
<tr>
<td>Act for each employer or client as faithful agents or trustees</td>
<td>Yes As an agent, you are expected to follow orders</td>
<td>Yes As an agent, you are expected to alert management to potential problems</td>
<td>Maybe Quitting a job is not bad faith</td>
<td>No As an agent or trustee, you may not make internal matters public without higher approval</td>
<td>No As an agent or trustee, you may not make internal matters public without higher approval</td>
</tr>
<tr>
<td>Avoid deceptive acts</td>
<td>No Assent to something you disagree with is deceptive</td>
<td>Yes You honestly reveal your disagreement</td>
<td>No Quitting to avoid responsibility is deceptive</td>
<td>Yes You honestly reveal your disagreement</td>
<td>Yes You honestly reveal your disagreement</td>
</tr>
<tr>
<td>Conduct themselves honorably …</td>
<td>No Deceptive assent dishonors the profession</td>
<td>Yes Honorable dissent is in accord with obligations</td>
<td>Maybe</td>
<td>Yes Honorable dissent is in accord with obligations</td>
<td>Maybe Might be publicity seeking, not honorable dissent</td>
</tr>
</tbody>
</table>
The ethical decision matrix is presented in Table I in blank form, so that readers can fill in their answers for the case described above. In each box, fill in one of the three words “yes”, “no”, or “maybe”, along with, where appropriate, an explanation in ten words or less. Every box must be filled in, if only with that single word “maybe”. An essential aspect of professional ethics is addressing all of the ethical dimensions, not merely the most salient or comfortable ones. Is it really appropriate to supply students with the alternative solutions that head the columns? Isn’t it better to ask the students to supply their own alternatives? In an extended ethics course it would be better. But in the limited scope of the first-year introductory course, we find that providing pre-selected alternatives meets two needs. First, it avoids a lengthy exercise that takes time away from addressing more important issues. Second, providing pre-selected entries allows the opportunity for students to discover at least one important point for themselves. In the interests of allowing readers of this paper to discover that point, its discussion is deferred to later in the paper. The ethical decision matrix is similar to another engineering tool, the design decision matrix. That similarity is not accidental. It is intended to reinforce the point that ethics is not a departure from engineering. It is an essential part of engineering. So it’s no surprise that the tools of engineering ethics share properties with the other tools of engineering.

After all students fill in their personal matrices, the general discussion can resume in a focused manner. In Table II, as an illustration, is a matrix filled in by one participant. The purpose of the discussion is not to dictate answers for each box, or to determine an unequivocally correct course of action. Rather it is to clarify ethical concepts, promote consistency of ethical thinking, and encourage discovery. Use of the matrix clarifies ethical concepts because it provides a way of determining whether or not the student really understands the meaning of the canons. Suppose, for example, the student fills in the box Act for each employer or client as faithful agents or trustees / Call a newspaper reporter with the answer “yes - freedom of the press permits it”. This shows some confusion about the concept of acting as an agent on behalf of someone else, as opposed to acting on one’s own as a citizen. Use of the matrix promotes ethical consistency. Consider, for example, a student who filled in the matrix in the way presented above. Note that such a matrix response would identify a student who nevertheless chose the option “go along with the decision” as acting in an ethically inconsistent manner. Such a course of action is ethically inconsistent because the column “go along with the decision” is dominated by the column “appeal to higher management”. That is, for every entry in the “go along” column, the entry in the “appeal” column is at least as good, and in some cases is better. It is ethically inconsistent to prefer an action if some other action is as good or better according to all the canons, and better at least one.

The matrix also highlights the dangers of a “vote” among the canons, if domination is not present. Consider, for example, the columns “inform management” versus, “write your state representative”. By a simple vote, “inform management” wins because it is superior by two criteria, while “write the representative” wins only once, the rest being ties. However, “inform management” may not be the best choice. Recall that word “paramount”. It means that the first canon must have the highest weight in the decision. That higher weight may be enough to overcome the two-to-one vote. There is room here for legitimate and consistent difference of opinion among respondents.

That legitimate and consistent difference of opinion often leads to a discovery. Maybe the best option is not one of the pre-supplied “canned” choices. Perhaps, for example, some “combination” option or “escalation” option is appropriate (in your discussion with the boss, you might politely make it clear that if the problem is swept under the rug, you will feel an ethical obligation to go public). Perhaps there is a better “outside” option than going to a state representative or a newspaper reporter. One major purpose of ethical deliberation is to invent a better option than initially provided by someone else’s suggestions or your own intuitions. Again, note the similarity to the engineering design process. Finally, by its modular and focused nature, the ethical decision process is easily applied to weekly homework problems, and to exam questions. For examples of applying the ethical decision matrix in all portions of a one-semester course, see our textbook, Exploring Engineering [4].

CONCLUSIONS

We propose a matrix approach, the ethical decision matrix. That approach helps students appreciate that engineering ethics problems are multidimensional. Students learn to address specific cases in a systematic way. The ethical decision matrix:

- Is practical in the limited time available
- Focuses on something both new to the student and important to engineering: the concept of a canon of professional ethics
- Complements, rather than conflicts with, other engineering tools, such as the design decision matrix
- Opens the opportunity for continued application in weekly homework problems
- Is testable
- Provides the opportunity for discovery

REFERENCES


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