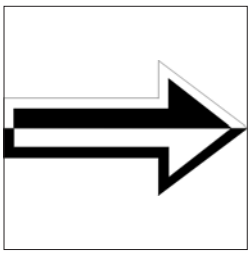

Article

Professional Engineering Ethics and Christian Values: Overlapping Magisteria

Gayle E. Ermer

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Many faith-based colleges and universities with engineering programs find themselves trying to simultaneously satisfy two educational objectives: (1) meeting the requirements of the Accreditation Board for Engineering and Technology (ABET) to produce graduates who have "an understanding of professional and ethical responsibility" and (2) meeting the goals of their own institution for student spiritual formation and development of Christian moral values. This paper will describe and analyze several approaches to understanding the relationship between these two objectives and the implications of these approaches for engineering education.

It could be argued that the two goals mentioned above are mutually exclusive. Since professional ethical standards arise out of a secular context and by means of purely logical reasoning, they bear no relationship to personal religious commitments. The implication of this view would be that all engineers need to be taught the engineering code of ethics without regard to any commitments they might have to religiously determined moral absolutes. It could also be argued that the two goals mentioned above are one and the same. Each individual appropriates an all-encompassing system of values and this system is operative in all situations, including professional engineering work. The implication of this view would be that engineers do not need to know the engineering code as long as their parents, early school experiences, church, and devotional life had contributed to a strong moral conscience.

This paper will argue that while each of the two areas has its own distinctiveness, each overlaps the other in content and depends on the other for successful ethical decision-making and action. This argument will be based on the Reformed Christian philosophical perspectives expressed by Abraham Kuyper and Herman Dooyeweerd. The paper will conclude with some practical suggestions for emphasizing the relationship between both domains within the engineering curriculum. A method for integrating engineering ethics into the technical portion of the engineering curriculum within the context of a Christian worldview will also be presented.

In 2002, I had the good fortune to be accepted into a National Science Foundation (NSF) sponsored workshop on Ethics Across the Curriculum in engineering and science. In the course of the workshop, I was introduced to several scholars interested in promoting engineering ethics among engineering practitioners and students. Their goals, and the methods promoted to achieve them, struck me as worthy initiatives. I came back to my home institution, Calvin College, and proceeded to implement many of the workshop's recommendations by designing our own Ethics Across the Curriculum program. But a niggling doubt about the effectiveness of this style of professional ethical analysis was generated by a comment made by the workshop instructor while addressing the issue of "freeloaders." The ethical theories and evaluation process discussed in the workshop assumed that professionals would

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adhere to their codes of ethics because logic dictated it was beneficial to do so (if everyone follows the code, the profession will be better able to achieve its humanitarian goals). But what about people who choose the profession primarily because of its financial or status rewards rather than to achieve the profession's goals? What would be their incentive to follow the rules rather than following their own self-interest? The workshop instructor seemed to indicate that the ethics principles we were discussing were inadequate to deal with someone who was not already willing to make sacrifices for the sake of professional goals (except to the extent that violation of the codes could be made to have serious consequences, which is not the case in engineering). The conversation at the workshop seemed to imply that religious faith or personal virtues were irrelevant to professional ethics.

In 2006, I sat on Calvin's all-college assessment committee. One of our main tasks was to draft a list of assessment outcomes for the college. The list included many of the standard goals for a college or university: we wanted our students to gain knowledge and skills as part of the educational process. But it became very clear as we looked at the Calvin College Expanded Statement of Mission[1] that our goals extended beyond knowledge and skills. We wanted our students to have knowledge of God and to understand their place in the world in light of that knowledge. We also wanted our students to develop certain attitudes or virtues. Clearly, it seemed to me, we have certain expectations for our students in terms of their values and ethics as they go out into the world to develop God's kingdom. But, I was struck by the fact that these "virtue" goals were completely unrelated to the kind of ethical knowledge and analysis presented at the NSF workshop.

I came to think that perhaps I had discovered two camps with quite different perspectives on questions of how we ought to convince engineering students and professionals in general to behave responsibly. This paper is an exploration of the ethos of each of these two camps and an examination of whether and how they are related to each other. I hope sharing some of these thoughts will be instructive to others who also have "feet in both camps" and wish to reconcile the goals and methods of each in ways that would allow engineering programs to best educate our students to respond appropriately to the ethical problems that they might encounter in their engineering careers.

The Two Camps

To clarify the problem of how these two camps are related, I will begin with a more thorough description of their goals and emphases. For the sake of brevity, I will refer to the emphasis reflected in the NSF workshop described above as the Professional Ethics camp, and the emphasis reflected in the assessment committee discussion described above as the Christian Values camp.

Professional Ethics: Goals, Content, and Methods

Every engineering program in the United States is required to satisfy the criteria of the Engineering Accreditation Commission (EAC) of the Accreditation Board for Engineering and Technology (ABET). This includes educating students to meet a list of specified outcomes, including those related to ethics: students must have

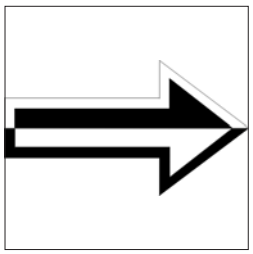
> c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability … f) an understanding of professional and ethical responsibility.[2]

Michael Davis (one of the sponsors of the NSF workshop), in his book, *Thinking Like an Engineer,* proposes that a profession is partially defined by its published Code of Ethics:

> The history of a profession tells how a certain occupation organized itself to hold its members to standards beyond what law, market, and morality would otherwise demand.[3]

If that is the case, the National Society of Professional Engineers (NSPE) Code of Ethics is an engineering mission statement. This code is representative of the codes for other engineering disciplines (although there have historically been differences between the various codes) and expresses the goals of the engineering profession as conceived of by its practitioners (Christian and otherwise) over the past century. The fundamental principles and canons are included in Table 1 (p. 28).[4] The entire code includes sections on Rules of Practice and Professional Obligations which amplify the canons substantially, but are not included here for the sake of length.

This approach to professional ethics emphasizes that engineering ethics is "special ethics," in the sense that the standards described in the codes do not necessarily apply to everyone generally (as would the standards of common morality), but are a special set of standards generated by the nature and content of the profession. Ethical requirements for a professional are based on the moral ideals of the profession. The result of implementing the mission of the profession is a set of standards the profession decides each practitioner must follow. Therefore, ethical expectations, or at least the weight given to different expectations when they conflict, may differ depending on the profession. For example, the primary responsibility of a lawyer is to promote justice, which may require a high priority placed on maintaining confidentiality of client information. For engineers, the safety of technology users and the general public is of the utmost importance (which may make confidentiality ethically undesirable). Although it might be easy to argue that the canons themselves (including the primacy of safety) merely summarize a set of



common ethical principles, examining the more detailed sections of the code reveals directives that are more specific to the discipline.

Those promoting this interpretation of engineering ethics emphasize using a "design process" (which is something very natural for engineers) to determine an action plan for ethical response in a given situation. This step-by-step problem-solving method includes developing a clear description of the ethical problem, gathering relevant data and principles, creatively generating possible responses, evaluating the responses, choosing an optimum response, and implementing the response chosen. Within the evaluating step, ethical theories, like utilitarianism or duty ethics, can be used to evaluate different actions.

Engineering codes and the methods of engineering ethics are supposed to guide the conduct of engineering practitioners. Unfortunately, there are reasons why this is not always the case for industrial engineering work. Many engineers have never heard of the code, since the vast majority of engineers do not belong to the professional organizations which generate them. This may indicate that despite the idealist rhetoric, engineers do not strongly identify with the ideals of engineering as a profession. In fact, many engineers work for organizations which have their own ethical codes. Though these codes are unlikely to directly conflict with the professional code, they may assign higher priority to values that are not seen as particularly helpful to the profession's goals (for example, a requirement not to disclose proprietary information).

The engineering code of ethics can be viewed by many engineers (and especially engineering students) as a somewhat arbitrary list of "do's" and "don't's" that discourages honest moral reflection and inhibits the development of personal conscience. As mentioned above, there are disagreements among engineers about the relevance of some of the more specific items in the code related to rules of practice and professional obligations. The canons themselves may not adequately reflect a robust understanding of the mission of the profession. If engineers were to "conduct themselves honorably, responsibly, ethically, and lawfully" (6), it seems unnecessary to specifically list (3), (4), and (5) which also emphasize honesty and responsibility. Pursuing honorable conduct "to enhance the honor, reputation, and usefulness of the profession" in (6) seems self-serving.

It is also worth noting that the wording of the fundamental canons is open to a great deal of interpretation. In today's postmodern and global culture, the meaning of a term like "honesty" cannot be assumed to be the same for all people. For example, some students do not view cheating as dishonest and in some cultures, lying is expected in order to avoid social conflict. Despite these problems, the engineering code of ethics provides a window into professional life, and if used conscientiously with an ethical decision-making process, can help to clarify the issues and provide direction in a given situation.

Another perspective on engineering ethics is provided by Martin and Schinzinger's influential textbook, *Ethics in Engineering*. According to this text:

> Engineering ethics consists of the responsibilities and rights that ought to be endorsed by those engaged in

Code of Ethics for Engineers

Preamble

Engineering is an important and learned profession. As members of this profession, engineers are expected to exhibit the highest standards of honor and integrity. Engineering has a direct and vital impact on the quality of life for all people. Accordingly, the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct.

The Fundamental Canons

Engineers, in the fulfillment of their professional duties, shall:

1. hold paramount the safety, health and welfare of the public.
2. perform services only in areas of their competence.
3. issue public statements only in an objective and truthful manner.
4. act for each employer or client as faithful agents or trustees.
5. avoid deceptive acts.
6. conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

Table 1. NSPE Code of Ethics

> engineering, and also of desirable ideals and personal commitments in engineering … Engineering ethics is the study of the decisions, policies, and values that are morally desirable in engineering practice and research.[5]

This not only supports the importance of codes, by stressing the responsibilities of those who choose the engineering profession, but it also broadens the discussion to include the implications for society of implementing different technologies. It also includes a short section on the importance of personal motivations and religious commitments to the practice of engineering.

Tau Beta Pi, the honor society for engineers, also places a strong emphasis on ethics. In recognition of some of the poor ethical choices being made among students (studies showing high rates of cheating) and among researchers (falsified and exaggerated results), in 2004, this organization, along with other college honor societies, generated a program titled "A Matter of Ethics" intended to encourage members to reach their full potential by "building upon the core of one's character, by encouraging honesty, trustworthiness, integrity … ethics."[6] This program does not focus on a code, but does promote the use of a set of guidelines for resolving ethical dilemmas.

Christian Values: Goals and Content

All faith-based educational institutions have goals for their students that extend beyond strict adherence to professional codes. These goals are often very broad and sometimes difficult to articulate, but they are directly tied to the mission and context of the institution. The recently adopted assessment outcomes for graduates of Calvin College, are listed in Table 2. Although ethics does not show up explicitly in the list, it is clear that knowledge of God, culture, and self, as well as skills in communication and reasoning, are all linked to the mission of the college to produce students who are committed Christians, doing what is right in all the roles they assume in their lifetimes.

Students who complete a Calvin degree should:

Develop and articulate knowledge of:

- God as revealed in Scripture and creation as expressed in the Reformed Christian tradition,
- The diverse cultural, natural, and social forces that shape our world,
- Themselves—their nature, gifts, and identity, and
- A chosen area of in-depth study.

Demonstrate skills in:

- Critical thinking,
- Sound reasoning,
- Effective communication,
- Problem-solving, and
- The particular methods of their area of in-depth study.

Demonstrate—given a Christian commitment—

- A devotion to the life of discipleship,
- A dedication to Christian virtues, and
- An active pursuit of their vocation in renewing God's world.

Table 2. Calvin College Student Learning Outcomes

The engineering department at Calvin has also developed its own objectives and outcomes for student learning. These are reproduced in Table 3. The first three items are general objectives, while the last three are a subset of more specific outcomes related to ethics. The very nature of these objectives implies that there can and should be an understanding of ethical responsibility that is distinctive due to a Christian framework of understanding the world. These objectives indicate that Calvin engineers are expected to have more than just a commitment to a set of professional ideals, but a commitment to the ideals of all Christians to spread the gospel, to mature in discipleship, and to promote justice and shalom in this fallen world.

Degrees of Overlap

Some members of each of the domains described above believe (or at least behave as if they believe) that the two

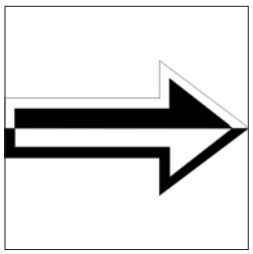
Department Objectives: *Students graduating with a BSE degree from Calvin College will be …*

- *… kingdom servants whose Christian faith leads them to engineering careers of action and involvement, to personal piety, integrity, and social responsibility, and to leadership with a prophetic voice advocating appropriate technologies;*
- *… firmly grounded in the basic principles and skills of engineering, mathematics, science, and the humanities, for correct, perceptive, and sensitive problem assessment at a level appropriate for entry-level professional work and graduate studies;*
- *… equipped to creatively move a project from problem statement to final design utilizing the interdisciplinary and interdependent character of the engineering profession.*

Department Outcomes: *Calvin's engineering program will demonstrate that its graduates have …*

- *(f) an understanding of professional and ethical responsibility from a Christian, holistic perspective,*
- *(j) engaged contemporary issues demonstrating how their Christian faith relates to their profession,*
- *(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice to develop responsible technologies*

Table 3. Calvin Engineering Department Objectives



There is nothing in the engineering code of ethics that directly conflicts with a Christian understanding of moral responsibility. … An engineering curriculum constructed to meet the goals specified in the code should therefore also be consistent with what a Christian engineer would want to teach.

domains are mutually exclusive. The professional ethics promoters see their domain as an essential part of engineering education, while viewing faith-based values as only tangentially related to the ethical decision-making ability of an engineer. One of the ramifications of this view for engineering education is that ethics becomes just another content area within engineering, similar to electronic circuit analysis or machine dynamics. All of these technical content areas (including engineering ethics) are viewed as independent of faith commitments.

One of the benefits of this approach for the educational process is the assumption that there is something distinctive to engineering ethics that can and must be taught. That is, engineering ethics is not like morality in general, which students absorb from a variety of sources, such as family upbringing, primary school experiences, church programs, and engagement with art and literature. Since students know, or at least think they know, this kind of morality already, engineering ethics gives engineering educators something to add. This approach also fits well with the preferences of many engineering faculty (including Christians) who feel uncomfortable discussing such "personal" issues as faith commitments and moral values in the classroom setting.

In today's postmodern cultural context, engineering professors do not want to be accused of sermonizing or indoctrinating students into particular worldview perspectives, which would imply intolerance of other systems. It is much safer to simply focus on the professional expectations which are particular to engineering work and which have broad application independent of worldview. From the professional ethics standpoint, engineering ethics can be taught the same way—wherever you are and whoever your students are. Some Christians also view engineering ethics this way, and do not see a need to make explicit connections between faith and ethics.

What is obscured by treating the two domains as mutually exclusive is the commonality of their goals. Most broadly, both the secular professional accrediting boards and Christian educators are concerned with encouraging professionals, including engineers, to do the right thing in their occupational activities. According to Davis:

> Because of the scale on which engineers generally work, engineering is particularly dangerous. Engineers long ago realized this and set about to ensure, as much as possible, that engineering would be used for good rather than evil.[7]

According to Martin and Shinzinger, one of the purposes of studying engineering ethics is to "increase one's ability to deal effectively with moral complexity in engineering."[8] These statements share some of the same concerns as Calvin's engineering student outcomes.

On the other hand, those promoting Christian values sometimes argue that engineering ethics is just a subset of general morality. Students should be encouraged to develop a broad Christian world- and life-view which encompasses their career along with all other aspects of living. The assumption is that good Christians will do the right thing because of who they are and what they believe, regardless of their profession. The educational focus should then be on inculcating Christian values into the person, rather than learning profession-specific standards and ethical decision-making methods.

In engineering education, the core curriculum of the college (or even chapel attendance and Bible studies) can be relied on to produce the sorts of people and develop the skills and knowledge to make appropriate ethical decisions, which those people will then carry into the engineering context. The implication is that special engineering ethics does not need to be taught as such, and codes are unnecessary. This attitude is prominent among some Christians who fear that using a code of ethics generated by secular individuals through purely logical processes may conflict with their absolute moral standards.

There is nothing in the engineering code of ethics that directly conflicts with a Christian understanding of moral responsibility. For the most part, these are goals that Christians can readily appropriate. Christians certainly want to use their knowledge and skill for the enhancement of human welfare, and to be truthful, faithful, and fair. The emphasis on safety holding priority

in design work is central to the engineering ethos. A Reformed understanding of common grace allows us to recognize that even those engineers without experience of God's saving grace can still do good in this fallen world. An engineering curriculum constructed to meet the goals specified in the code should therefore also be consistent with what a Christian engineer would want to teach. Certainly our ultimate loyalty does not belong to our clients or employers, to our profession, or even to the public. But, in most cases, serving these constituencies faithfully can be an expression of our ultimate loyalty to God. This should mitigate the fear that appropriating this "secular" approach is a danger to Christian values.

Strengths and Weaknesses of Each Approach

In order to educate engineers who can truly further God's kingdom through their work with technology, we need to identify the strengths and weaknesses of each of the domains described previously, and appropriate the best contributions of each to achieve our goals. Table 4 summarizes some of these. Further elaboration of the bulleted items will be included in this section.

The value of the engineering ethics approach centers around the usefulness of the tools and the direct connection provided to engineering practice. Engineering ethics has a very strong problem-solving focus. Usually, a step-by-step approach is advocated for designing a solution to an ethical problem. This recognizes that most ethical choices are not right/wrong, but better/worse. The choices are constrained by multiple factors and often involve prioritization of competing factors (tradeoffs) along with the element of creativity. This is something engineers gravitate toward and have experience with in their technical work. In fact, there could be significant benefits in exporting this approach to the liberal arts side of the curriculum. The professional ethics perspective makes good use of ethical theories for helping to clarify ethical problems and evaluate the merit of particular responses to those problems. The engineering code can also be used as one of those evaluative tools. Engineering ethics has the added attraction for students of focusing on case studies and situations that are directly relevant to their chosen career path. It can expand their understanding of the complexities involved in contributing to a large-scale engineering project once they graduate and of what will be expected of them both technically and ethically as professionals.

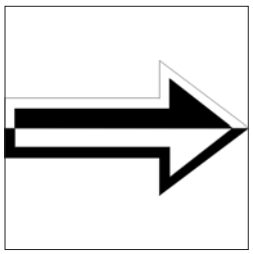
Engineering ethics appeals mostly to the intellect. In this sense it can be reductionistic. The assumption is that an engineer needs to know certain things in order to do what is right. The impression is given that ethical problems are just like technical design problems, which in a way they are. But, often behaving ethically requires more than just knowledge. Empathy and willingness to sacrifice personal gain for the greater good are also needed. An engineering code of ethics embodying the profession's goals usually functions as an extrinsic motivator. The code is applied as a legal document, forcing practitioners to follow the rules for fear of penalties, rather than emphasizing conscience. Professional ethics does not speak very much to the intrinsic motivation that is necessary for someone to care about behaving ethically in the first place and to have the will to carry out ethical actions. The code can also be interpreted as providing the minimum requirements for adequate engineering practice, rather than encouraging individuals to pursue the best possible contribution to the profession from an ethical standpoint.

The engineering ethics methods tend to address individual decision-making within a limited context (micro issues), rather than system level consequences of organizational or corporate decision-making in society. As such, the codes (currently, at least) do not address all the principles Christians care about. An obvious example is the lack of inclusion in the NSPE code of any ethical responsibility to the environment and sustainability. The Christian values approach should encourage reflection on the overall ideals of the profession. In this way, students are encouraged to think beyond the micro issues of a particular ethical dilemma toward broader issues of how technology can benefit society.

The Christian values side emphasizes holistic personal development. This is often neglected in engineering ethics education (or given only lip service). The truth is that each individual needs personal character to be committed to behaving ethically in the engineering arena. The knowl-

	Strengths	Weaknesses
Engineering Ethics	• Design Approach • Ethical Theories • Relevant Examples • Industry Expectations	• Reductionism • Extrinsic Motivation • Micro Issues • Minimal Approach
Christian Values	• Intrinsic Motivation • Macro Issues • Holism	• Broad Principles • Maximal • Conflicting Principles

Table 4. Distinctive Features of Each Domain



I want to characterize the two domains focused on in this paper as "overlapping magisteria." … I see the relationship between professional engineering ethics and Christian values not as one of isolation, but as overlap and interdependence.

edge of professional expectations and codes can help, but so can a recognition of Christ's claim on us to become more like him through the power of the Holy Spirit. The Christian values approach lends itself more readily to consideration of issues at the macro scale, such as social justice. These issues are especially important for engineers to think about as they move into management in industry or help to develop government policies governing technology.

The weaknesses of the Christian values approach include the fact that it tends to focus on broad principles that are difficult to apply to specific technical problems. It is even more difficult to apply these principles when they seem by nature to conflict (for example, justice and mercy). These values are naturally considered to be maximal in nature, that is, the claims of faith have priority over all of our decisions. In an extreme case, taking the demands of living our Christian commitments seriously can cause a student to consider leaving engineering in favor of professions that seem more obviously tied to their Christian calling, like missions or full-time church work. It can be helpful in these cases to emphasize that engineering as a profession is dedicated to serving society, and that Christian engineers can participate in the profession as a means for Christian service.

Overlap and Dependence

I want to characterize the two domains focused on in this paper as "overlapping magisteria." The phrase references Steven J. Gould's characterization of Science and Religion as "nonoverlapping magisteria."[9] I see the relationship between professional engineering ethics and Christian values not as one of isolation, but as overlap and interdependence. The explanations above support this interpretation from a practical standpoint, but reasons for this conclusion also are supported by a Reformed Christian philosophical perspective.

It is inevitable that people bring personal values (or worldview) to their understanding of ethical responsibility, including with respect to their occupation or profession. Reformed Christians emphasize that all of creation belongs to God; therefore, professional ethics, along with all other human activities, needs to reflect our Christian faith. Hermann Dooyeweerd, expanding on the insights of Abraham Kuyper, argues that everyone approaches theorizing (about ethics or anything else) with an accepted set of presuppositional commitments. This shapes the process and affects the outcomes of their theorizing.[10] So, it makes a difference how engineering ethics problems are approached and solved if those involved are committed to Christian presuppositions.

One key Christian presupposition is that God is the Creator and Sustainer of all things. He is the only nondependent entity and all of creation is ultimately dependent on him. Many non-Christians elevate something in creation to the position of God, for example matter and/or energy. Those who choose something within creation as nondependent, or "divine," must necessarily explain all of the world's activity in terms of the divine.[11] This leads, for example, the physical naturalist to explain life processes and human emotions, as well as everything else, in terms of interactions between molecules. A Christian can assert that God has created a multi-faceted universe in which activities are not reductionistically explained by one domain's set of laws. In fact, all phenomena for humans are experienced holistically, that is, all of our God-given faculties interact with the complexity of the creation. But, God has also created in us the capacity to abstract things from this holistic picture in order to understand them better and determine their God-ordained structure. The ethical aspect is one of those areas which can be abstracted in order to discover the rules governing this area, but actual ethical decisions and actions cannot be separated from the other aspects, including the physical and the social, among others.

One implication of this perspective is that professional ethics should not be reduced to the logical aspect, which engineering ethics tends to do. We can acknowledge the contributions of secular theories of ethics to the discussion of ethical problems, but we should retain a healthy skepticism toward the claim of any particular ethical theory of providing definitive answers. The secular theories and processes upon which the domain of engineering ethics is founded can contribute many good ideas, but ultimately they may need to be modified and combined to fit the

more robust picture of what is good for society provided by a Christian worldview. Neither can the ethical aspect be reduced to the faith aspect, as Christian values tend to do. We ought not to assume that anyone with a Christian commitment will make the right choices with respect to technological design, since the ethical and economic aspects have distinctive explanatory theories. An engineer needs to have specific information related to expectations of the profession and the character of modern technical society in order to correctly assess the ethical implications of his or her work.

Integrating a Christian Perspective on Ethics into the Curriculum

If the domains of engineering ethics and Christian values can be understood as overlapping magisteria, then how can Christian engineering educators better tie together the domains and integrate them into the engineering educational process? I suggest three methods for injecting the strengths of both areas into the engineering curriculum.

First, engineering education at all levels should focus on the concept of vocation as a link between the profession of engineering and the commitment to Christian service. Professional occupations in technology, mathematics, and the sciences provide opportunities for Christians to fulfill the calling to serve God and others by reforming his creation. Byron Newberry, in an essay in the Fall 2005 issue of *Christian Scholars Review* entitled "The Challenge of Vocation in Engineering Education," discusses the benefits and trials of building in students the identification of their engineering career with the service to which God has called them by virtue of their gifts, talents, and opportunities.

Second, all of the design experiences in the engineering curriculum can be presented along with a holistic set of design norms, such as those presented in Table 5. These design norms are requirements for technology based on a biblical worldview that reflects the holistic setting in which designs operate.[12] These design norms expand on the narrower concept of ethics captured in the engineering code and emphasize broader issues. The norms provide a way to tie Christian values with specific engineering problems. The norms also emphasize the need to make tradeoffs in design between technical as well as ethical considerations.

Technology Should Promote …
• Cultural Appropriateness
• Transparency
• Stewardship
• Harmony
• Justice
• Caring
• Trust

Table 5. Design Norms

Third, all of the ethics-related topics are best integrated into the technical curriculum via "micro-insertion." Rather than requiring an ethics course, or simply relying on other core subjects in the liberal arts to introduce ethics, inserting ethics issues into technical courses in small chunks is an optimal way to maintain engineering student interest in ethics and promote awareness of the relationship of ethics to industrial practice. Engineering students are not as interested in hypothetical issues as they are in what they are likely to experience as professionals in industry.

Ideally, the micro-insertion approach would fill the need for continuity in exposure to ethical issues throughout the engineering education experience and provide a structure for building on previous concepts. At the first-year level, students could start with simple problems where doing the right thing is relatively obvious. The "design process" for ethical decisions can be introduced, with a focus on gathering relevant information (such as professional codes of ethics and biblical principles). Later in their engineering education, they can be asked to consider more complex problems with significant ambiguity. The emphasis can shift to evaluating ethical solutions that have technical, as well as economic and political implications. There should also be a natural flow over the years from "micro" problems involving personal actions over which individuals have a high degree of control to "macro" problems embedded in institutional and societal structures which require more than individual action.

Case studies are a particularly useful way to micro-insert ethics topics into technical courses. In the "Introduction to Engineering" course that I teach to first-year students, I have used the "Catalyst B" case study developed by Michael Pritchard at Western Michigan University,[13] which presents students with the situation of a newly hired engineer who is asked by his boss to ignore some data in a report supporting a design decision. Although the case is hypothetical, it is very important for students to recognize that there may be times in their careers when, based on their personal convictions and understanding of professional obligations, they need to say "no" to an employer despite the potential for adverse consequences. This case study allows students to search the code for relevant expectations, while also determining for themselves what honesty requires in this situation, allowing both personal values and the engineering ethics analysis methods to contribute to a correct assessment of the problem.

Conclusion

Technology and the interactions of technology with individuals and society are becoming more and more complex. Knowledge of the technologies themselves and methods used to produce them are necessary to determining moral actions with respect to technology.

Since engineers bear a great deal of responsibility for technological development, they need to be aware of the ethical expectations of their profession. Christian values go deeper and are more personal than the considerations of professional engineering ethics as it is often taught in secular settings. Without an appropriate value system, it is difficult to establish the importance of engineering ethics and to motivate individuals to choose the interests of their profession over their own.

We need to avoid the "two camps" mentality and allow the strengths of both approaches to contribute to a robust understanding of the ethical responsibilities involved in being an engineer. We also need to integrate ethical issues into the engineering curriculum in a way that allows them the prominence they deserve relative to technical considerations. Christian engineers and scholars should be encouraged to continue to explore the connections between faith and action, between personal morality and professional ethical responsibility, and between ethical theories and technological practice. Engineering students and practicing engineers need to carefully consider a holistic approach to ethics and their work in order to direct technological development along a path that truly serves the kingdom of God. ☙

Notes

[1]*An Expanded Statement of the Mission of Calvin College: Vision, Purpose, Commitment*, rev. ed. (February 2004).
[2]ABET Engineering Accreditation Commission, *Criteria for Accrediting Engineering Programs* (Baltimore, MD: ABET, 2007), 2.
[3]Michael Davis, *Thinking Like an Engineer: Studies in the Ethics of a Profession* (New York: Oxford University Press, 1998).
[4]From the National Society of Professional Engineers (NSPE) website: www.nspe.org/ethics/ eh1-code.asp
[5]Mike Martin and Roland Schinzinger, *Ethics in Engineering,* 4th ed. (New York: McGraw-Hill, 2005), 8.
[6]From the Association of College Honor Societies (ACHS) website: www.achsnatl.org/ethics/ index.asp
[7]Davis, *Thinking Like an Engineer,* 16.
[8]Martin and Schinzinger, *Ethics in Engineering,* 9.
[9]Stephen J. Gould, "Nonoverlapping Magisteria," *Natural History* 106 (March 1997): 16–22. Gould described the relationship between science and religion as being a relationship, not of conflict, but of different domains, each prepared to address different questions. I tend to disagree with this interpretation of the relationship of science to religion.
[10]See L. Kalsbeek, *Contours of a Christian Philosophy: An Introduction to Hermann Dooyeweerd's Thought* (Toronto: Wedge Publishing Foundation, 1975).
[11]See Roy Clouser, *The Myth of Religious Neutrality: An Essay on the Hidden Role of Religious Beliefs in Theories* (Notre Dame, IN: University of Notre Dame Press, 1991), chaps. 2 and 3.
[12]See Stephen Monsma, ed., *Responsible Technology* (Grand Rapids, MI: Eerdmans Publishing Company, 1986), chap. 9.
[13]This case study can be found online at http://ethics.tamu.edu/pritchar/an-intro.htm under Larom, along with others.

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